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VOL I. No 4. DECEMBER: 1894.

A PRACTICAL JOURNAL FOR MACHINISTS AND ENGINEERS
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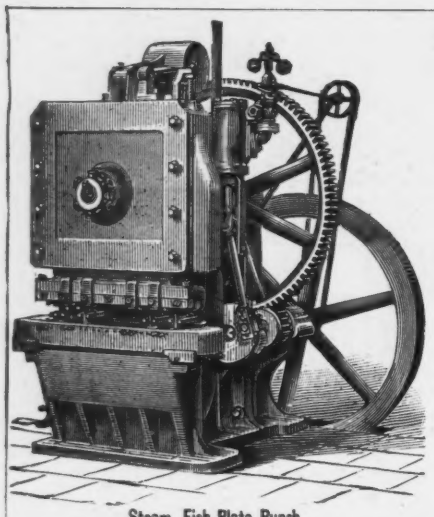

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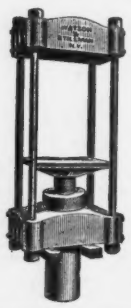

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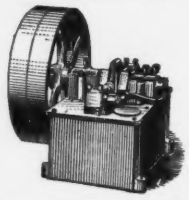

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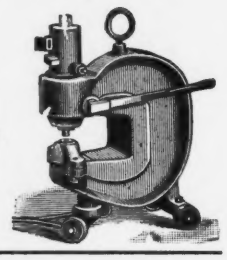

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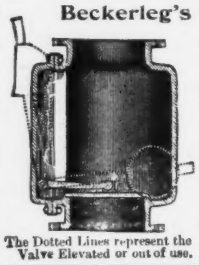

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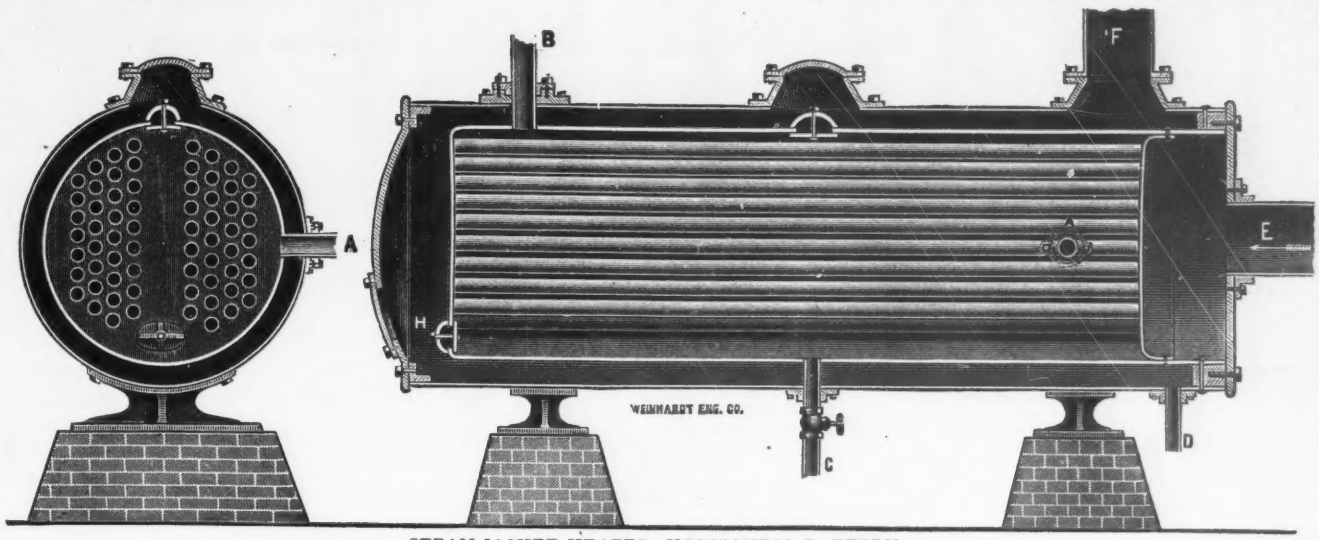

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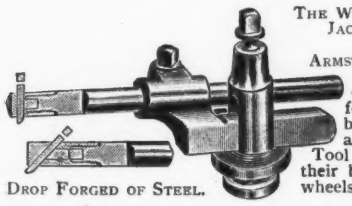

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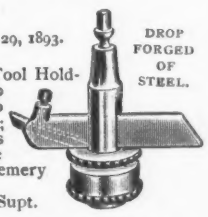

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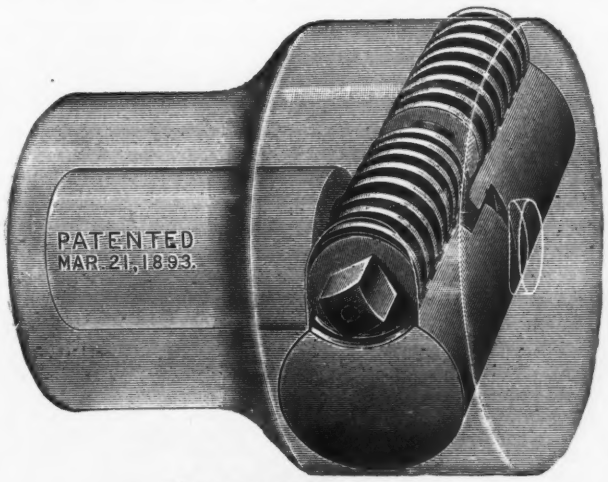

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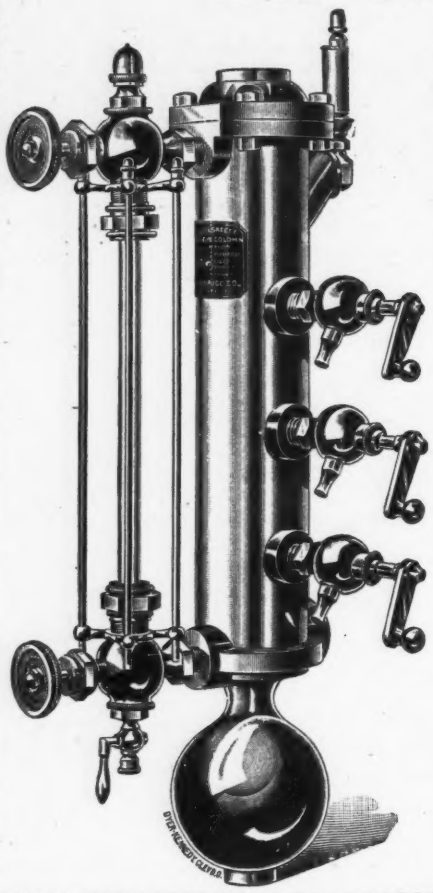

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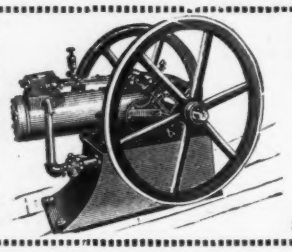

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MACHINERY.

VOL. 1. December, 1894. No. 4.

POINTS ABOUT TURRET LATHES.

JAMES HARTNESS.

THE present condition of the market has brought the question of labor-saving machinery to the front with greater prominence than ever before. The cost of production must come down and labor-saving machinery seems to offer the most effective means.

Wage cutting seldom cuts the cost in the machine shops; if it does, it only amounts to a reduction of from 10 to 20 per cent., while labor-saving machinery often cuts the cost of the labor 75 and 80 per cent. Of all the labor-saving machines for the machine shop there is none receiving more attention at the present time than the turret lathe. This is in part due to the fact that lathe work comprises a large percentage of the entire machine shop work, but I think it is more largely due to the recent development of the various types of turret lathes for this class of work.

James Hartness

The variety of purposes to which these machines have been applied has called for many designs embracing the original type, now known as high turret lathe, with its short working length and adaptability for work requiring great swing and the flat turret lathe, low swing and long working capacity.

It is my purpose to call attention to the principal features of design of the turret machine now on the market for machine shop use, and to do so forgetting as much as possible my "turret machine politics," for I believe that an impartial presentation would result beneficially to the makers and users.

It is a noticeable fact that there is no builder of turret machinery who excels in all fields of the work, although some have evidently aimed to do so only to find that one or two sizes of their machine has proved successful, while other sizes perhaps of the same design were failures.

The various sizes of work requires not only a change in size of the machine and tools, but often a change in design of either, and sometimes both; for instance, the tool known by the name of "box tool," consisting of a holder into which is affixed a series of cutters arranged to turn a number of sizes simultaneously, is invaluable on the sizes of work below ¾ inch diameter, where frequent sharpening of tools is not necessary, but its use on the largest sizes, especially on work of any considerable length and above 1½ inches in diameter, is impracticable. I will mention a few of the causes of its failure on large work: *First*, the difficulty of setting each of the cutters, not only for diameter, but also for exactly the length desired, results in a serious delay owing to the increased frequency of this operation on large work. *Second*, the large work is stiffer and will not spring enough to make up for the slight difference in alignment of the work and box tool. *Third*, a box tool designed to give the best results must be made as compact as possible, and when so made has only a very slight range of adjustment. For this reason a machine fully equipped with box tools would cost so much that interest on the investment would cover a large gain. *Fourth*, the first cutter in the box tool must travel through metal producing an exact size the whole length of the piece of work, and each cutter must begin its cut from the extreme end of the piece regardless of where its work proper is to be performed. *Fifth*, the box tool is of necessity an "overhanging" tool, and for this reason alone would be barred out from the field of long work.

The change in construction of the tool as well as the dimension of the work, operate to cause a change in construction of the entire tool-holder carriage of the lathe. These changes can best be noted by beginning with the original turret lathe and then following the successive designs.

The turret lathe evolved from a machine designed for making small screws and similar parts in gun work. This machine was first called a screw milling machine; afterwards this name was shortened to screw machine.

The overhang of the ram as it pushed to its most forward position was insignificant, as was also that of the tool; but as this type of machine was built in larger sizes it was found to be lacking in stiffness and rigid control of the tools. Just as in planer work, the shaper is the best for short work and is entirely unfit for long work, because of its overhang; so in the turret machine a change of design was necessary to take the long stroke.

The overhang of the turret slide was overcome by placing the turret on a carriage fitted directly to the bed and thus dispensing with the ram and box into which the ram had been fitted. This change greatly improved the machine for larger work, but did not wholly remove the faulty points of design, for although there was no overhang of the ram there was still the overhanging tools. Out of this condition grew a machine using a plate-like revolving tool holder which was given the name of turn-table

turret lathe and afterwards forced to accept a name given by its users, viz.: the flat turret lathe. In this machine this turret was arranged to pass under the work and to receive its tools on the upper surface The projection of the tool from the holding surface of the turret in this case was much less than in the original type, and furthermore, the position of the turret being directly under the cutting strains, was in much better position to rigidly resist any tendency of the tool to deviate from its true central position. This machine seemed to be particularly adapted to producing work from the bar or forging, such as shafts, pins of all kinds, from the pin having a number of sizes and shoulders down to the plain bolt having only one size and screw thread. It has also been found a very accurate tool for intricate chucking work of small diameter. Larger chucking work requiring a swing over 20 inches can still be best handled in the original type of turret lathe. For this work the turret is usually made hexagonal in form for the purpose of receiving either large boring or facing tools, and this type of machine is generally built to employ an engine lathe or similar carriage which has the additional advantage of working on the outside of large diameters. These machines have been built extra heavy to make up for their overhanging parts, and they are veritable battle-ships, slow moving on account of cumbersome construction, but of powerful and sure action.

Designers of all of these machines have aimed to produce lathes for the machine shop use embodying the following points: An unyielding control of the work and tools, the greatest possible accuracy for duplication, simplest form of cutting tools, and last, but not least, convenience of manipulation.

The unyielding control of the work and tools has never been accomplished, although the results at the present time are so infinitely superior to the results obtainable from the regular machines in which this work was previously done, that it seems quite proper to say that we now have obtained machines which give substantially an unyielding control. In passing it may be well to call attention to the advantages of such construction. It is so often remarked that a cutting edge will stand as long in one machine as it will in another, that I feel justified in calling attention to the fact that a cutting edge of tool steel when presented unyieldingly to its work will stand against a very heavy cut, for then there is almost no transverse strain on its edge, there being only that resulting from clearance, and that is extremely slight when all the conditions are considered. Transverse strains on the cutting edge such as evidenced by a chattering machine, may not break off a large piece of the tool, but yet be sufficient to destroy the nice cutting edge; hence the infinite value of a machine so constructed in all its parts from the chuck to the cutting tool that a practically unyielding presentation of the work and tool is possible.

Accuracy for duplication is the next point to consider. This feature is the distinguishing feature between the engine lathe and the turret lathe, and the *degree* of accuracy makes a distinguishing feature between the various types of turret lathes. Apparently a machine designed to give an unyielding presentation of the work and tools would also give accuracy for duplication; but this is not true in all machines. The tools in the turret are so arranged that one tool passes out of position to make room for another. Now the accuracy of the return of each tool to its original position measures the accuracy for duplication. The turret is locked in its various positions by an index pin that enters a nicely bushed hole in the bottom of the turret. This part of the construction is always executed with the greatest possible accuracy and care. The diameter of this index is made as large as possible, but, of course, cannot be larger than the diameter of the turret. For this reason, when overhanging tools are used, the index does not have sufficient control over the working part of the tool. In such machines the turret is clamped into whatever position the index pin may determine. After it is clamped it will give an unyielding control to short tools, but the tool may not be locked exactly in its original position.

The simplest formed cutting tool is absolutely necessary to obtain the best results, especially where quick change and convenience for grinding and resetting the tools are considered. This point is amply set forth in what I have said regarding the box tool.

The comparative simplicity of construction of the various turret lathes for a given class of work in a large measure indicates the comparative value of the machine for the general machine shop. Not that this one point should decide exclusively, but that this point should be considered as one of the first importance. No machine will succeed in this field that is unduly complicated. Such a machine will invariably give place to that of simpler construction. Simplicity of construction involves not only a question of number of parts, but also the various lines on which the machine is built. The more direct the connection between the work and tools and the less the distance it is necessary to travel going from the end of the tool back into its holder, down into the carriage and around through the bed, the head, the chuck, and to the work, the shorter this distance the stiffer will be the machine. For this reason the swing should never be greater than is absolutely necessary. So much has been said regarding the importance of putting more pig iron into the construction of machines that we too often forget that there is a possibility of going beyond in this matter. The turret machine of a necessity carries on its sliding head a large number of tools for the various operations. If it is built on the stiffest lines and is made light as possible, it is still heavy. The sliding parts that must be handled by the operator are so heavy that they would be greatly improved if it was possible to make them still lighter, and this illustrates the difference between the turret machine and other classes of machinery, where it may seem almost impossible to get too much iron into their construction.

The question of weight of machine is of smaller importance than the question of lines of design. The cost of the metal entering into the construction of the latest types of turret machines is so small when compared with that of the labor, that no designer would be so "penny wise and pound foolish" as to make the machine lighter than would be best according to his judgment. The turret is no longer mounted on a large number of sliding surfaces to travel at all angles except in cases where such travel is absolutely required, for every sliding surface between the tool and the bed means one more place for lost motion and one more chance for the tool to deviate under the working strains. By reducing the number of slides it is possible to reduce the number of handles, and this simplifies the operation as well as the construction of the machine.

Convenience of manipulation is in part the natural outcome of simplicity of form of the entire machine, including the tools. In observing a running machine, we see that much time is lost between cuts, also in adjusting the machine for a new piece. In this particular respect there is a vast difference between the machines now on the market Some machines may be readily adjusted to turn out a single piece of a kind and at the same time maintain a high efficiency on large lots. While others possessing good records on large lots are wholly unfit for use on lots requiring less than from three to six days' work.

The progress of the turret lathe indicates that the machinist trade of the future will be somewhat different from the machinist trade of the past. That engine lathes will be used only where all kinds of work is expected from each lathe. That where it is possible to classify the work, turret lathes will be used. There is one gratifying feature in the development of the turret lathe, which I believe pays a great compliment to the intelligence of the machinists in this country, and that is, although it is a labor-saving machine which invariably takes the place of from three to four and sometimes six engine lathes, yet is very rare that the machine has received any antagonism from the machinists. I have yet to learn, however, of the first case where the turret machine has thrown men out of employment, but I know of many instances where shops have been able to secure work when using the turret machines that otherwise could not have been taken. Good wages cannot be paid to men using inferior implements. Orders cannot be taken by companies so equipped, without they are satisfied with small profits and poorly paid workmen.

* * *

It is a bad practice to put an over-loaded belt down out of sight, especially where there is any inflammable material. The slipping of a belt on its pulley from overload is a good heat producer, especially if the belt hooks happen to stop in contact with the pulley. The writer saw a case of this kind several years ago, and the stream of sparks that came from that pulley rim would have done credit to a Chinese pin-wheel. Such occurences are dangerous, and precaution should be taken to render them impossible.

NAVAL TORPEDOES AND THEIR MANUFACTURE.

WARREN E. WILLIS.

To make a live fish, endow it with brains and muscle, so that when free from control it shall go on a predetermined course, at any desired depth, with as much accuracy as a rifle ball, at a speed of twenty-five miles or more per hour, the last few yards as rapidly as the first, and carry with it a load of destruction sufficient to annihilate a modern war vessel, is the aim of the torpedo manufacturer.

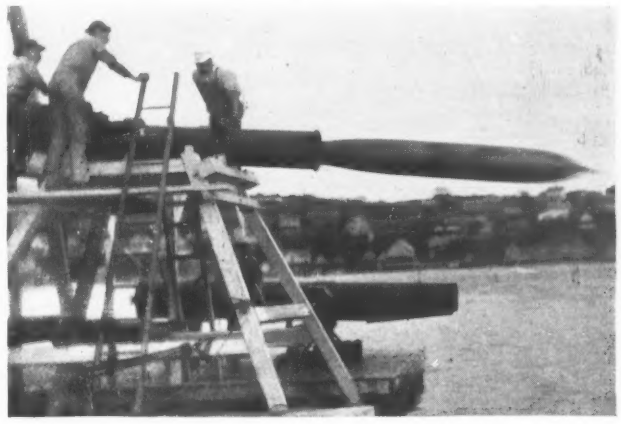
Of the half dozen or so of types that would answer the above description the better known are the Howell auto-mobile and the Whitehead, which latter is a foreigner, although according to Ex-Secretary of the Navy Tracy, "it has been successfully domesticated."

Both are of the fish variety, with cigar-shaped points; in dimensions about 12 feet long and 14 to 18 inches in diameter; average weight 500 pounds.

With the appearance of the exterior the difference between the two types end, and as the writer is not pleading the special merits of either he will not have occasion to enter into the details concerning the Whitehead further than to mention that its power is derived from compressed air and its action quite dissimilar for obtaining like results.

By referring to the view given a fair idea of the appearance of the Howell as built by the Hotchkiss Ordnance Co. may be had. The fins shown serve to keep it on its course and prevent deflection or rolling. The automatic steering is done by means of rudders or vanes contained in the fins, action being imparted to them through the medium of tiller-rods passing into the interior and acted upon positively by direct force from the motive power. The action is consequent upon a delicate adoption of the force of gravity: the position of the torpedo if other than level causes a carefully balanced pedulum to oscillate, or rather swing, to maintain its perpendicular; this swing moves upward a finger or catch, connected with inner end of tiller-rod, so as to engage with a constantly reciprocating part, moving at high velocity and thus actuating the horizontal rudder or vane. Upon the torpedo reaching a horizontal or level plane again this action is released. A similar action is also used to control the tendency to roll.

Power is abundantly supplied by a heavy fly-wheel running at an initial velocity of ten thousand turns per minute; this wheel is geared directly to twin propellers. Of course the effort to attain and keep up the great speed of the torpedo in the water rapidly reduces the velocity of the propellers, but to compensate for this provision is made in the blades so that an increased pitch is produced in order that the speed throughout its course in the water shall be practically uniform. The depth of immersion is secured by the known resistance or buoyancy of sea water at the desired depth, through the medium of a flexible diaphragm, to a spring, the opposing forces just neutralizing each other; the difference of a few inches in depth being sufficient to put in operation, by means of suitable mechanism, the rudders to raise or lower the torpedo as required. The forward end is arranged to carry a charge of about one hundred pounds of gun cotton, or other high explosive, to be ignited by concussion. A light charge of powder is used to throw the torpedo free from firing tube; only sufficient is used to accomplish this, and is not to be considered as forwarding the torpedo on its course, as the propellers are in motion before the discharge and take hold of the water at once. A peculiar form of steam turbine, known as the Dow motor, is attached to the side of the tube and connection made direct to fly-wheel shaft, the same being disconnected at instant of firing.



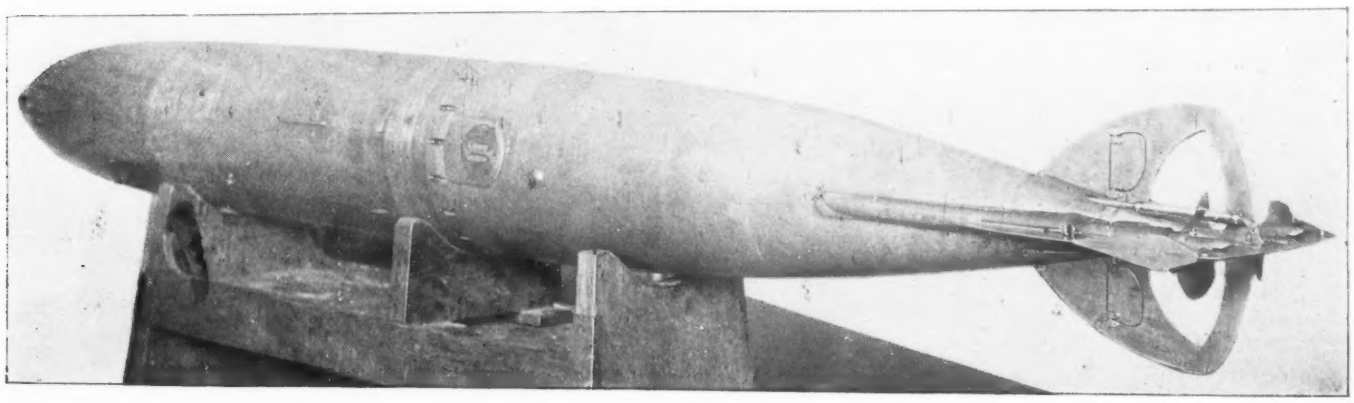
FIRING.

The requirements call for the torpedo to be so constructed that it may be safely blown from the mouth of the tube at an elevation as high as fourteen feet from surface of water. This is a rather severe test for a complex mechanism weighing five hundred pounds and one calling for considerable depth of water in which to recover itself and return to set depth. It may be well to state here, however, that the displacement of the torpedo entire is equal to the same bulk of water, or in other words that bulk for bulk the specific gravity is the same.

An ingenious arrangement is used to accelerate the return to depth, from initial dive, by the action of immobilizing mechanism, causing the rudders to act positively upward as the torpedo moves forward under the impetus of the propellers; this action is very carefully estimated and timed to the plunge. Probably as much thought, care and skill are required to produce these peculiar and interesting features as any line of manufacture.

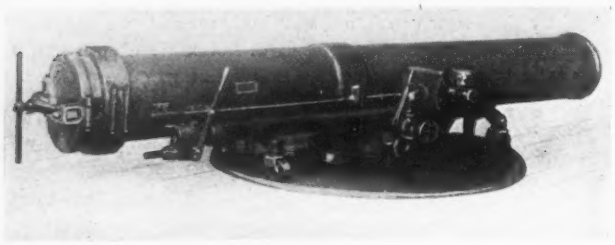
The views show the act of firing, the torpedo complete, regulating mechanisms, and a few details of the propeller blades and sliding cams, pitch cam gearing and depth register, which last is an interesting piece of mechanism in itself.

It may be well to say here in passing from the torpedo to the tools that all parts are of the lightest possible character consistent



HOWELL TORPEDO.

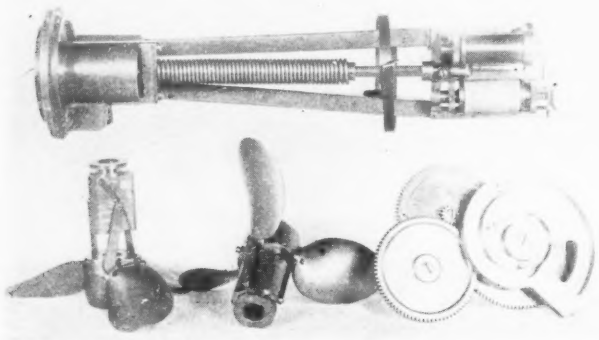
with the necessary strength; many of the castings are of particularly difficult shape to machine and call for consideration in designing tools not always needed.



FIRING TUBE.

It often becomes necessary to locate work in jigs or fixtures relative to certain unfinished points that do not need machining, yet for good reasons cannot be neglected or disregarded.

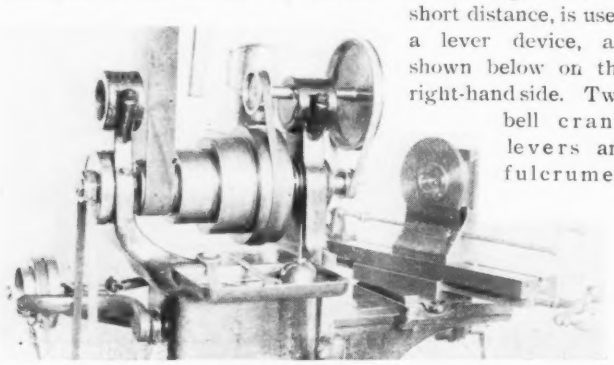
For instance, a casting called a "buffer" is of thin section with parallel sides and oval ends; it has an opening in the center or like shape, with raised edges; the outer sides are machined to gage, but the ends are not, although it is required that the inner edges be of equal distances from the center. As they vary somewhat in length, one from another, locating from a fixed point is inadmissible, as whatever variation existed would be all at one end. After removing the roughness by filing or otherwise and planing the sides, they are placed in the jig, which has projecting lugs fitted to match the planing. Other projections reaching from the



PROPELLERS, ETC.

jig through the opening serve to support and guide two hardened pins, or plungers, which are of the same length; these plungers are caused to abut at their inner ends, by a helical spring, against a stud, the two opposite faces of which are shaped like a spiral cam; this stud is free to revolve on its axis, being fitted for a wrench to turn it by. It will be readily understood that a partial revolution will force the plungers equally outward, causing the work to come central with the stud, while a reverse motion will release the work so far as the functions of the plunger and cam are concerned.

It is not always that the interior of work can be so readily reached or that the needed room is to be had. In the case of another part, which has the top covered, but sides opened for a short distance, is used a lever device, as shown below on the right-hand side. Two bell crank levers are fulcrumed



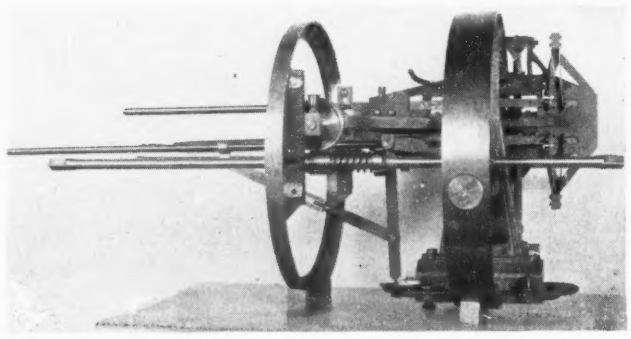
HIGH SPEED MILLING.

on base of jig, with both inner arms actuated by one cross piece, which is caused to move to and from the work by a knurled head-screw, which also serves as a guide. Equal accuracy is attained by either motion. This same lever principle is also used in locating work from the exterior, as at the sides or ends, either from rough or finished surfaces.

To return to the special tools, the right-hand figure represents a jig, the special feature of which is the strong and rapid manner of drawing the clamp to its seat and releasing the same when desired. An explanation seems unnecessary. On the left-hand side is shown a jig, which is adapted to operate on two lengths of a like shaped piece, the part carying the V block being detachable, or rather removable, to another location.

It may be noticed that wherever possible some form of cam is used, the vexations of stripped threads, poor fits and parts working loose are thereby largely avoided, besides much time saved in operating.

These illustrations and explanations are given only as representing some of the varied forms of the special tools as used on



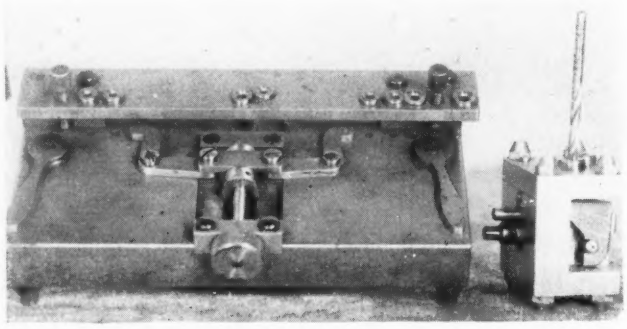
REGULATING MECHANISM.

the torpedo, which is exclusively bronze work, and not as showing anything particularly new or strikingly different from those used in other places.

A very neat shop device is shown representing a high speed attachment for a milling machine and a cam cutting device. By suitable connections to the feed the latter is made automatic in its motions, and in connection with the attachment makes a decidedly satisfactory rig; the latter, by the way, should be credited as the invention of Mr. Frank Mossburg, of Attleboro, Massachusetts.

CAST IRON BEARINGS.

For heavy bearings there is nothing better than good cast iron, and in many places they are superior to bronze. The main thing is to keep them thoroughly lubricated until they "glaze," after



SOME OF THE JIGS.

which there is little danger from cutting, if they are properly cared for. They outwear bronze, and consequently need less "lining up," and are much cheaper for large bearings. In one heavy turret lathe, to the writer's knowledge, they have been running over ten years, and are in perfect condition. If a bearing is to be neglected, use bronze or babbitt, as the damage to the shaft will be less if they become dry, for cast iron cuts badly when dry. But if a bearing is to receive the care it deserves, and is run carefully a day or so, there will be no trouble from cast iron, and it is superior to bronze in several ways. Nor is extra care required, for we see nearly all line shafts run in cast iron boxes, and not receiving the best of care either; but one saving feature is the length of bearings which can well be followed in other places, where room permits.

* * *

THE *American Machinist* has added Mr. Chas. M. Jones, well known in marine engineering circles, to their already efficient editorial staff.

THE PATENT PRIVILEGE.

G. P. WHITTLESEY.

When an ingenious mechanic has made a good invention, either by careful study or by being struck with a happy thought, his next desire is to make some money out of it. Fortunately for him, the law provides a way to do this. In olden times an idea was common property as soon as its author had communicated it to other people. There was no way by which he could prevent them from copying his improved plow, or his new pump, or anything else he may have designed and built in order to lighten his labor. But gradually it came to be seen that the work of a man's brain was worthy of protection quite as much as the work of his hands; that there was no great inducement for an intelligent mechanic to spend his time and money on a new labor-saving device if, when it was done, the law merely protected his property right in the ownership of the thing he had constructed, and left the idea, the kernel, to be adopted by everyone who chose.

It was, therefore, a wise provision of our Constitution which empowered Congress to secure to authors and inventors for limited times, the exclusive right to their writings and discoveries. I do not mean that this was the first time such an enactment had been made. But it has led to the most liberal patent laws which the world has ever seen.

The first United States patent law was passed in 1790. It required every application for a patent to be examined by the Secretary of State, the Secretary of War, and the Attorney General, and these three officials actually did pass upon the applications first filed.

Imagine Secretary Gresham, Secretary Lamont, and Attorney-General Olney attempting to go through the forty odd thousand applications filed every year! This law of 1790 was revised from time to time until our present law, the Revised Statutes of 1874, went into force.

The grant of a patent, therefore, is a matter depending entirely upon statute law. It is a privilege, not a right. The privilege consists in being able to secure, for a term of seventeen years, the exclusive right to make, use and sell the invention. This right is granted in return for a full and complete communication of the invention to the public, so that at the expiration of the term the public may be able to practice the invention. In figurative language, the Government may be said to build a fence around the inventor's territory and give him the sole right to collect admission fees to the enclosure for a limited time, in consideration of an unreserved description by the inventor of the things enclosed by the fence, so that when the fence is taken down the public may know just how to enjoy the new field then added to its possessions.

Since a patent is a purely artificial form of protection, based upon laws made by Congress, it follows that Congress has the power to repeal all the patent laws if it chooses, and leave the inventors of the land to protect themselves only by keeping their inventions behind locked doors and in the hands of employees sworn to secrecy. The disastrous effect such an occurrence would have upon all manufacturing and all future enterprises can hardly be imagined. The mere mention of it is sufficient to impress one with the fact that the great majority of our manufacturing establishments depend for their prosperity upon the protection afforded by the patent laws. With their machinery, or their processes, or their products, or all three, covered by good patents, they are freed in a great measure from competition, while every improvement in manufacture which reduces the cost, or gives a higher priced product at the cost of a lower priced one, can be taken advantage of to the exclusion of all rival concerns.

This very fact is a stimulous to continued study and experiment, resulting in rapid, and in many cases wonderful, advances in all lines of invention, until to-day we are acknowledged to stand at the head as a nation of inventors.

It is advisable, therefore, for all inventors to take advantage of the patent laws and protect their inventions. They should keep all sketches and models, and date them when made.

They should not be afraid to explain their ideas to their most trusted friends, whose testimony will be invaluable in case it is ever necessary to prove the history of the invention before the Patent Office in an interference proceeding, or in court in a suit against infringers of the patent. An invention should not be neglected, but followed up to completion, and a full-sized specimen built if possible. The law favors a diligent inventor. As soon as an idea has been worked out, either on paper or in wood or metal, it is well to submit it to some good patent attorney who, for five dollars, will make an examination at the Patent Office to see if anyone has patented it before. The inventor will then know whether it is worth while to go to the expense of obtaining a patent, which will cost from sixty-five dollars upward, according to the nature of the invention.

The Government fees are the same in all cases, but the attorney's fee varies with the amount of work he expends on each case. It is best to avoid the cheap attorneys, and those who advertise "No patent, no pay." A good lawyer's services are always worth paying for, since he constantly does all he can to serve the best interests of his client. Patent law is an intricate and abstruse branch of practice, and the services of a skilled solicitor are often absolutely necessary to obtain a strong patent. This is urged by the Patent Office in its published Rules of Practice. If an inventor wishes to get the address of a reliable patent attorney, he may safely ask the editor of any good mechanical or trade paper.

* * *

A COUPLE OF PATTERN-MAKING NOTES.

JOHN M. RICHARDSON.

On visiting one of the largest and best known shops in New England during my summer vacation, I saw on one of the patterns that had been brought to the foundry to be moulded, what to my mind was the cleverest trick to avoid an awkward core that had ever come under my notice. I will not attempt to reproduce the pattern here, which in fact I cannot do from memory, but will give a simple illustration involving the principle, which may perhaps come in handy on some job to the pattern-makers who may read this.

Fig. 1 represents a deep shell with a shank or hub sticking out at right angles to one side on the interior, and this in turn with a spot at right angles to itself, which at first sight renders it an awkward thing to mould.

The conditions are that the shell is too deep, and the sides too nearly square to cope out the inside, and also that no core box is to be made. This still further increases the apparent difficulty, but it is only "apparent," as I will now show.

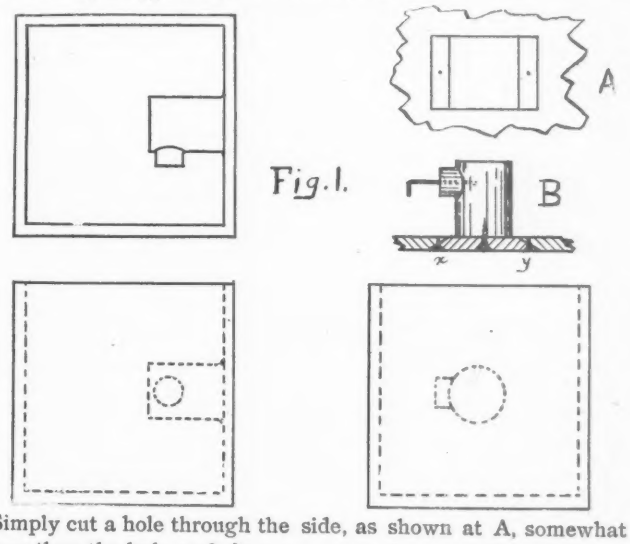


Fig. 1.

Simply cut a hole through the side, as shown at A, somewhat larger than the hub, and fit a cover, as shown at B, and fasten with two screws. Next lay out the exact position of the large hub and fasten it with one or more screws to the part just men tioned. The small spot is attached loosely by means of a wire, as shown.

Now a word just here about fastening round bosses to either cylindrical or plane surfaces. Do not do extra work. Use but one wire, and bore the hole while the boss is in the lathe. This insures the absolute center, and is best done by just countersinking a little place with the turning tool, and then pressing a twist drill firmly and squarely against the work. The drill should be just enough larger than the wire to work freely after the pattern is shellaced, without being loose. It is impossible for a circular spot to take a wrong position against a plane surface with one central wire, and likewise on a cylindrical surface, if the moulder sees that it bears squarely when he rams the sand against it.

Now, to return to the pattern itself, the moulding is as follows: After being placed on the mould-board, with the open side upper-

most, it can be rammed up, and after the inside is filled and the wire removed, and before the outside is completed, loosen the two screws *x y*, and draw back the portion of the side with the hub attached. next pick back the small spot through the opening thus made, then unscrew the hub from the side piece and lay it one side, and return the other to its former position by means of the same screws *x y*, and continue ramming the nowell as if nothing had happened. It will be seen that there is now only a simple flat cope, and the expense of a print with its attendant core-box has been avoided.

Another point noticed during this visit was that the letters composing the maker's name, location, etc., were made on the different machines by using dry sand cores, instead of applying pattern letters directly to the patterns. On reflection this method seems to have both an advantage and a disadvantage. The core-box used was a common open frame box with sides perhaps ⅞ inch high, and a bottom board, and into this bottom board a brass plate was let in flush, containing the letters. One size of core-box will answer for a variety of machines, and thus save affixing a very large number of letters to various patterns, which are liable to get knocked off, and a plain core-print can be attached to the pattern in a fraction of the time.

Another important point is that if letters are fastened to a large pattern the mould is liable to be broken in removing the pattern, and the letters cannot be patched up (at least without great difficulty), whereas, with the core, if a poor one is made it can immediately be thrown away and replaced in a moment.

Providing fine sand is used, and a due amount of care exercised in making the core, the only disadvantage I can see is that of its falling into the hands of careless moulders who will not take proper care in setting it in the mould, and thus make a bad line on the casting, showing the boundary line of the core, which emery brick and paint will not conceal.

This negative supposition should not be entertained in connection with any first-class foundry, and is not tolerated in the foundry I have in mind, and the results there are certainly very fine.

* * *

THE DESIGNING AND CONSTRUCTION OF MODERN STEAM ENGINES.—3.

THEO. F. SCHEFFLER, JR.

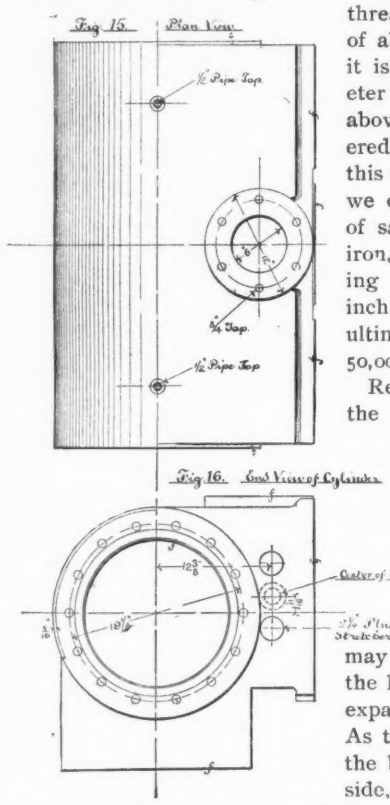
Referring to the illustration of cylinder, Fig. 12, is a cross-section through steam and exhaust ports; Fig. 13, a longitudinal section through center of cylinder; Fig. 14, a longitudinal elevation; Fig. 15, a plan view, and Fig. 16 an end elevation. Having settled on the general design of cylinder, the first thing is to calculate the thickness of cylinder wall, or barrel. We will apply the following formula:

$$T=\frac{D\,P}{4000}+\frac{3}{4}$$

T=thickness of cylinder in inches.
D=diameter in inches.
P=maximum initial pressure in pounds per square inch, and ¾=a constant.

As our maximum initial pressure is 125 pounds, and diameter 16 inches, we have D=16 inches, and P=125 pounds, and 16×125=2000, dividing by 4000 we have .5 inches plus ¾ we have 1¼ inches for thickness at smallest point; it should be this thickness for total depth of counterbore; the cylinder bore proper will be $1\frac{5}{16}$ inches thick, on account of counterbore being ⅛ of an inch larger than bore of cylinder. The thickness of cylinder flanges should be 2¼ times the diameter of cylinder studs, and as the studs are 1 inch in diameter we have exactly 2¼ inches for thickness of flanges. In calculating the diameter of cylinder studs, they should be figured at the bottom of thread, and the pressure per square inch should not exceed 3,200 pounds at maximum initial pressure. Allowance should be made for screwing the nuts up tight, this in itself is no small strain on the stud. As the diameter of cylinder-head is 16⅛ inches where it fits into cylinder, the area of head would be 204.21 square inches, and multiplying 125 pounds initial steam pressure, gives 25,526.25 pounds total pressure, which the studs must resist; as we have 14 studs, we divide 25,526.25 by 14, which gives 1,823.3 pounds pressure on each stud. To calculate the area of stud at bottom of thread, we divide 1.823.3 by 3,200 pounds, which gives .569 of an inch area; this is practically equivalent to a stud .84 of an inch in diameter at bottom of thread, which gives a stud exactly 1 inch outside diameter. This stud will be large enough to resist all necessary friction caused by screwing the nuts against the head. Referring to Fig. 14, we observe that the size of steam-chest inside the flanges is 9½×17⅜ inches, or 165.06 square inches area; to obtain the total pressure on each steam chest stud, multiply 165.06 by 125 pounds steam pressure, and divide by the total number of studs, which is 12, therefore, 165.06×125=20632.5, divided by 12=1719.3 pounds pressure on each stud.

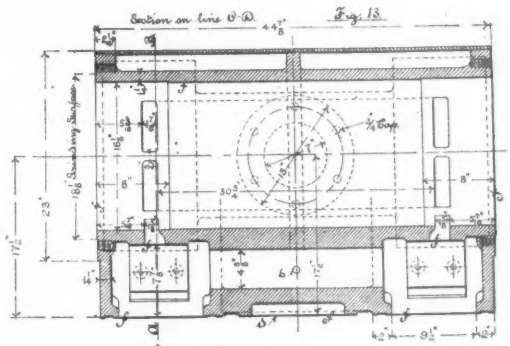
These studs should be calculated the same as the cylinder-head studs, *i. e.*, allowing 3,200 pounds per square inch. Dividing 1719.3 pounds by 3,200 gives .537 of an inch area for stud, which is equivalent to a stud $\frac{13}{16}$ of an inch in diameter at bottom of thread, and outside diameter of about $\frac{15}{16}$ of an inch, but, as it is better to avoid all diameter of studs in sixteenths, the above stud should be considered ⅞ of an inch in diameter; this will be amply large, when we consider the large factor of safety for refined wrought iron, giving in this case, allowing 3,200 pounds per square inch, a factor of 15.6, with an ultimate breaking resistance at 50,000 pounds per square inch.

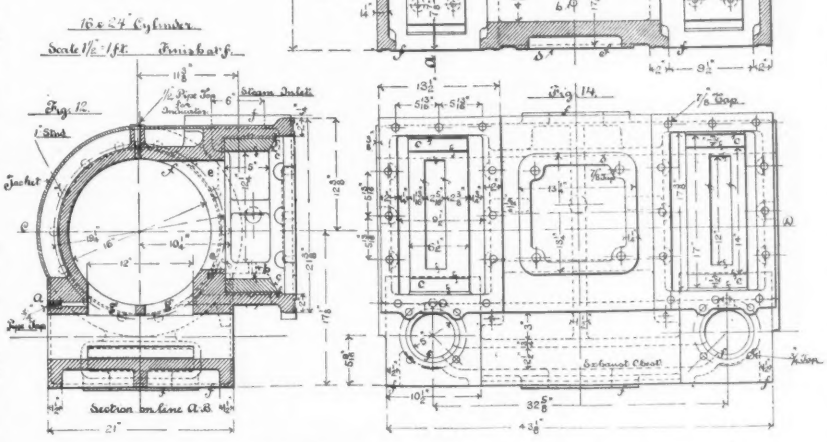


Referring to Fig. 14 we find the exhaust chest is situated as far as possible from the cylinder barrel, in order that the exhaust steam, which has been reduced to a comparatively low temperature, may be prevented from robbing the live steam of its heat while expanding behind the piston. As the cylinder is jacketed on the bottom, as well as on the side, the space in between the jacket and cylinder should be filled with asbestos blocks, which will retain the heat and prevent loss by condensation of the expanding steam. In order to determine the total length of cylinder, we must be guided by the piston and the valve; as the piston should be 28 per cent. of the engine stroke in thickness, we have 24×.28=6.72 inches for thickness, or practically 6¾ inches; add to this the stroke of engine and we have 30¾ inches plus the clearance between piston and cylinder-head, when crank is on the dead center. As it is customary to make this clearance about $\frac{3}{16}$ of an inch and sometimes $\frac{5}{32}$ of an inch, we will assume in this case $\frac{3}{16}$ of an inch for clearance, therefore: $30\frac{3}{4}+\frac{3}{16}+\frac{3}{16}=31\frac{3}{8}$ inches between cylinder-heads; from this point we must figure from the valve and width of steam chest. As the width of steam port on entering cylinder is 1⅝ inches wide, and as $\frac{3}{16}$ of an inch of the width is clearance space, and subtracting, we have $1\frac{5}{8}-\frac{3}{16}=1\frac{7}{16}$ inches from edge of port to cylinder head on each end of cylinder, therefore: $31\frac{3}{8}+1\frac{7}{16}+1\frac{7}{16}=34$ inches to outside of each steam port. (See Fig. 13.) As the steam lap is $\frac{11}{16}$ of an inch, and the travel of valve 3 inches, we must calculate the necessary amount of room for valve to work in, and yet keep this space down as much as possible, for if the steam chest is made too large, the steam will condense much more rapidly than if we had a small steam chest, thereby adding to the water consumption. The valve-seat should be designed so that the valve will run over the edge about ⅜ of an inch on each end of the seat when the valve is at the extreme end of the stroke; the valve-seat designed this way will not wear a shoulder. This distance, taking in the lap of valve and the amount necessary for valve to travel in, is $1\frac{13}{16}$ inches. (See Fig. 14.) The distance from outside of valve-seat to edge of steam-chest flange, should be 1¼ inches to give the necessary room for valve when at the end of its stroke. We have now only the width of flanges and ⅜ of an inch on each end outside of this for the extreme length of cylinder, and adding up we have: $34+1\frac{13}{16}+1\frac{13}{16}+1\frac{1}{4}+1\frac{1}{4}=40\frac{1}{8}$ inches, and adding the width of flanges, which is 2 inches on

each end, we have $40\frac{1}{8}+2+2=44\frac{1}{8}$ inches, to this we add the $\frac{3}{8}$ of an inch on each end, which gives $44\frac{1}{8}+\frac{3}{8}+\frac{3}{8}=44\frac{7}{8}$ inches over all for length of cylinder. It will be noticed that the valve-seat for steam is in close proximity to bore of cylinder; this is done to lessen the clearance to some extent. The seat should not be so close as to prevent planing off after having worn down. The exhaust valve is also very close to the cylinder bore, and allowance is made for reboring at any time. The area of exhaust chest should be about one and one-half times the area of exhaust port, which would make it 31.6 square inches, but to suit the conditions of the cylinder it has been made 30 square inches; this will be sufficiently large to accommodate the volume of exhaust steam, even at $\frac{3}{4}$ cut-off of stroke. After leaving the exhaust chest, the exhaust steam continues through the 7 inch exhaust pipe, either to the heater, if one is used, or to the condenser, if the engine is running condensing. The area of the 7 inch exhaust pipe is 38.48 square inches, which is about 35 per cent. larger than the steam pipe. The area of steam pipe is calculated from area of piston and piston speed in feet per minute. Multiply area of piston (201.06 square inches) by piston speed, which is 680 feet per minute, and divide by 4,800, therefore: $201.06\times680=136720.8\div4{,}800=28.48$ square inches, which is the required area of steam pipe.

The constant 4,800 is found by allowing 80 feet per second velocity for steam, and multiplying by 60 seconds, for one minute, which is correct for ordinary practice. Referring to Fig. 12, the $\frac{3}{4}$-inch pipe tap at *a* is for the purpose of draining the condensed water in the exhaust port, by means of the cylinder cock, and connected to cylinder cock, but entirely independent, there is an automatic relief valve, which will open when any water gets into the cylinder when the engine is running, and probably save smashing a cylinder-head. There are various causes for water getting into cylinder, by the boiler foaming, and by improper pipe connection from boiler to engine. The main throttle valve should always have a drip pipe connected to it, just above the valve-seat, to drain off all condensed water before starting the engine. There should also be located a $\frac{3}{4}$ inch drain at the bottom of steam passage between the two steam chests; this hole is designated at *b*, Fig. 12. The square flange *d*, Fig. 14, is designed for the purpose of bolting to the wrist-plate bracket; this will be described in a later paper. Referring to steam chests, it will be noticed that the valve-seat is $1\frac{3}{4}$ inches from flange on one side, while on the opposite side it is only $1\frac{1}{4}$ inches, which we previously described. It is made $1\frac{3}{4}$ inches on one side to give clearance to the planing tool, while planing the seat. This steam chest is designed for a double-ported balanced valve, to be used with a pressure plate of very heavy construction; and the distance pieces *c c*, Fig. 12, are for the purpose of supporting the pressure plate, when the steam pressure is on it. These distance pieces should be made about $\frac{2}{1000}$ of an inch thicker than the valve to give the best results, and take the pressure from the valve; and the pieces should be fitted to the valve and steam chest when they are under expansion from being warmed up, which will bring them to their natural working condition. The distance pieces are made a little tapering on top, where the pressure plate presses againt them. This is done to relieve the pressure at bottom of valve and on top, the pressure being on the pressure plate will have a tendency to force the distance pieces away from the valve, thereby permitting a film of steam to enter between the valve and distance pieces, both on the top and bottom; this space, however, should not be more than $\frac{1}{1000}$ of an inch; it will also allow the valve to be thoroughly lubricated, and for the end expansion of valve. With the generous wearing surface that the valve has on the seat and on the bottom and top, there will be but little wear on the valve, and with proper attention and thorough lubrication, it should not wear appreciably for a number of years. The valve, if properly scraped and fitted, with the small amount of pressure on it, should never get to cutting. If, however, after a number of years of wear the valve should begin to leak to some extent, it is only a matter of disconnecting the distance pieces from the steam chest and scraping them once more, until the pressure plate is close to the valve, but not so close as to pinch the valve in any way.





Another point in favor of this design of valve is its small size, the valve being about 5 inches in width and 14 inches long. A detail drawing of it will be given in the next paper. The valve being comparatively narrow, and the distance pieces being exposed to the steam the same as the valve, no trouble should be experienced by having the valve bind by expansion. Any over-pressure by water in the cylinder is relieved the same as with any ordinary slide valve, by lifting from its seat, and while the valve is liable to wear down by riding on the lower distance piece, it does not open a leak over the top, as is the case with piston valves Allowance is made in the valve for this wear on the bottom side of valve, by having plenty of clearance between valve and valve-rod, so as the valve wears down it will not spring the rod. After the valve has been working for some time and wear occurs, the lower distance piece can be raised up sufficiently by thin packing pieces, so as to restore the valve to its original location. To calculate the clearance in the cylinder, it is necessary to know the exact amount of space contained in both the steam and exhaust ports on one end of cylinder. By clearance we mean the percentage of piston displacement contained in the ports up to the face of the valve-seat and between cylinder-head and piston, when the crank is on dead center. Length of stroke multiplied by area of piston equals the piston displacement. We must also calculate the amount of space between cylinder-head and piston, when the crank is on the dead center. The total displacement is therefore: $24\times201.06=4825.44$ cubic inches. As there is $\frac{3}{16}$ inch clearance between the piston and cylinder-head, we multiply area of $16\frac{1}{8}$ inches by $\frac{3}{16}$ inch, therefore: 204.21 area of piston multiplied by $.1875=38.28$ cubic inches; this we divide by 4825.44, which gives .0079 per cent. of piston displacement between piston and cylinder-head. It is now necessary to calculate the amount in steam ports. It is more accurate to calculate the cubical contents of ports with a planimeter.

Referring to Fig. 12. the area of steam port at *e e* is 35.84 square inches as found with planimeter; average width of port is 1.979 inches, therefore: $35.84\times1.979=70.92$ cubic inches in steam port; this we also divide by 4825.44, which gives .0146 per cent. of piston displacement in steam port. Area of exhaust port at *g g* is 25.6 square inches, and multiplied by width $1\frac{7}{8}$ inches$=48$ cubic inches divided by 4825.44 gives .0099 per cent. of piston displacement in exhaust port. We now add together results found: $.0079+.0146+.0099=.0324$, or 3.24 per cent. piston displacement in cylinder; this is not all of the clearance, as there will be some in the cylinder-heads, where heads lap over ports, and are cut out to admit steam freely, and exhaust port is cut out to exhaust freely. This clearance will amount to about .0079 per cent., this added to .0324 makes a total of .0403 per cent of piston displacement, or about 4 per cent. clearance. With this small amount of clearance the engine will be very economical in regard to water consumption, and will also afford a gradual cushioning action for piston to compress against.

In the next article of this series we will illustrate and describe the steam valve with pressure plate and exhaust valve.

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DECEMBER, 1894.

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THINGS TO BE CONSIDERED.

Nothing helps the introduction of a new machine or device among practical mechanics more than simplicity of design and the absence of numerous joints and pieces, which tend to shorten the life of the machine as well as impair its efficiency. Joints are good things to avoid where possible, as the inevitable wear is followed by lost motion, which affects the accuracy of the machine. It is safe to say that the main reason that the link motion has never been successfully rivalled in locomotive practice is that all substitutes, while perhaps giving a little better steam distribution, had so many more joints and wearing surfaces exposed to the dirt and dust of the road, that wear, lost motion, and derangement followed in quick succession. There are many other cases that might be cited, but this will serve to show the necessity of keeping design and construction as simple as possible, where practical success is desired.

Another very important consideration is the question of shop economy as affected by the amount of unnecessary, if not wholly useless, work that is so often done, generally because some one else did it before, and often the highest barrier to improved methods is the one of precedent.

Putting aside the question of employment for labor on work that serves no other purpose, we are confronted by a vast amount of what may well be termed "useless work." Beginning with the drawing-room, where much time and valuable eyesight is wasted trying to draw threads to their proper size and angle, when a few plain marks, with the pitch given in figures, will serve every purpose. The same can be said of drawing gear-teeth for any other purpose than finding the correct shape for the tooth. In the shop we find parts finished and polished by hand, involving much labor, when a neat coat of paint will look nearly as well and be much cheaper. This might be continued in many different directions, but it is needless. The amount of labor and material expended in useless work, from the standpoint of mechanical utilization, would add greatly to the world's production and leave more time for the production of new machinery and new ideas. Abolish all the useless work, from the drawing-room to the sales-room, and note the resulting economy.

* * *

IS IT ECONOMY?

We recently visited a shop where room was at a premium and where castings had to be piled up in heaps to allow passage for men and materials, yet there were several places where room could have been saved and more efficient work done by the expenditure of a few hundred dollars in new and modern tools. To be more explicit, all the cylinder boring was done on an old lathe of large swing and long bed, taking up twice the floor space that a vertical boring mill would have done, and not turning out nearly as much work in a given time. To be sure the old lathe, with its boring bar, could do nice work, but the element of time enters largely into modern machine shop practice as well as the economical use of space, where shop room is limited, and it leaves little excuse for the old machines being retained. And this also affects the machinery market to a considerable extent, for the use of modern tools increases the demand for their manufacture and benefits both maker and user. In fact, it is rather amusing to hear the maker of one kind of machinery complain of people's folly in not buying the best machine on the market, when perhaps he is a living example of this folly in his own shop and in the manufacture of his own machine.

But there are many such places, and there are probably few of us who are not open to this charge of inconsistency in a more or less aggravated form. The fact remains, however, that it is not economical to use out-of-date tools, except under special conditions.

THE GENERAL PRINCIPLES OF MACHINE DESIGN.*

PROF. C. H. BENJAMIN.

The working or moving parts of a machine should be first designed and the frame then adapted to them, as the only reason for the existence of a frame is that it may guide the motions of the sliding and rotating pieces. The moving parts can be first arranged to give the motions and velocities desired, special attention being paid to compactness and to the convenience of the operator who shall use the machine when completed.

Novel and complicated mechanisms should be avoided and the more simple and well tried devices used. Any device which is new should be first tried in a working model before being introduced into the design. A designer should never strive to be original at the expense of simplicity.

The dimensions of the working parts for the necessary strength and stiffness must next be determined and the design for the frame completed. This last may involve some modification of the moving parts, since the best machines are but compromises in the effort to reconcile conflicting conditions.

In designing any part of the machine the metal must be put in the line of the force, and bending avoided as much as possible. Straight lines should be used for the outlines of pieces exposed to pulling or pushing forces, circular sections for all parts liable to be twisted, and curves of uniform strength for pieces subjected to bending action.

Superfluous metal must be avoided, and this excludes all ornament. There should be a good practical reason for the presence of every pound of metal in the machine.

It may be sometimes necessary to waste metal in order to save labor in finishing, and in general the aim should be to save labor even at the expense of stock. This shows how necessary it is for the designer to be familiar with all the shop processes as with the principles of strength and stability.

The usual tendency in design, especially where cast iron is used, is towards unnecessary weight. All corners should be rounded for the convenience and comfort of the operator, and no cracks or sharp internal angles left, where dust and grease may accumulate, and in general special attention should be paid to so designing the machine that it may be conveniently and safely operated, that it may easily be kept clean, and that oil holes are readily accessible. The appearance of a machine when in use is generally a key to its working condition. Polished metal should be avoided on account of its tendency to rust, and neither varnish nor bright colors tolerated. The filling or paint should be of a neutral tint and have a dead finish, so as not to show dust or scratches.

Beauty is an element of machine design, but it can only be attained by legitimate means which are appropriate to the material and its surroundings. Beauty is a natural result of correct mechanical construction, but should never be made the object of design. Harmony is another important element in design and may be secured by adopting one type of cross-section and of contour and of adhering to it throughout. For instance cored or box sections should never be combined with ribbed sections if it can be avoided. In cast pieces the thickness of metal should be uniform to avoid cooling strains, and for the same reason sharp corners should be absent. When apertures are cut in a frame either for core prints or for lightness, the design is more pleasing to the eye if the apertures themselves are symmetrical figures rather than the surrounding metal.

Machine design has been a process of evolution. The earlier types of machines were built before the general introduction of cast iron frames, and had frames made of wood or stone, paneled, carved and decorated as in cabinet work. When cast iron frames and supports were first introduced they were made to imitate wood and stone construction, so that in the earlier forms we find panels, mouldings, gothic traceries and elaborate decorations of vines, fruit and flowers, the whole covered with contrasting colors of paint, and varnished as carefully as a piece of furniture. Relics of this transition period in machine architecture may be seen in almost every shop. One man has gone down to posterity as actually advertising a drill press "designed in pure Tuscan."

MACHINE SUPPORTS.

The fewer the number of supports the better. Heavy frames, as of large engines, lathes and planers, are best made so as to rest directly on a masonry foundation. Short frames, as those of shapers, screw machines and milling machines, should have one support of the cabinet form. The use of a cabinet at one end and legs at the other is inharmonious and offensive to the eye. If two cabinets should be used provision should be made for a cradle or pivot at one end to prevent twisting of the frame by an uneven foundation.

The use of intermediate supports is always to be condemned, as it tends to make the frame conform to the inequalities of the floor or foundation, on what has been termed the "caterpillar" principle. The use of legs instead of pillars on the cabinets, broad at the base, is an assumption that the frame is stiff enough to resist the stresses which come upon it unaided by the foundation, and also implies the idea of being moved from place to place like a chair or a table.

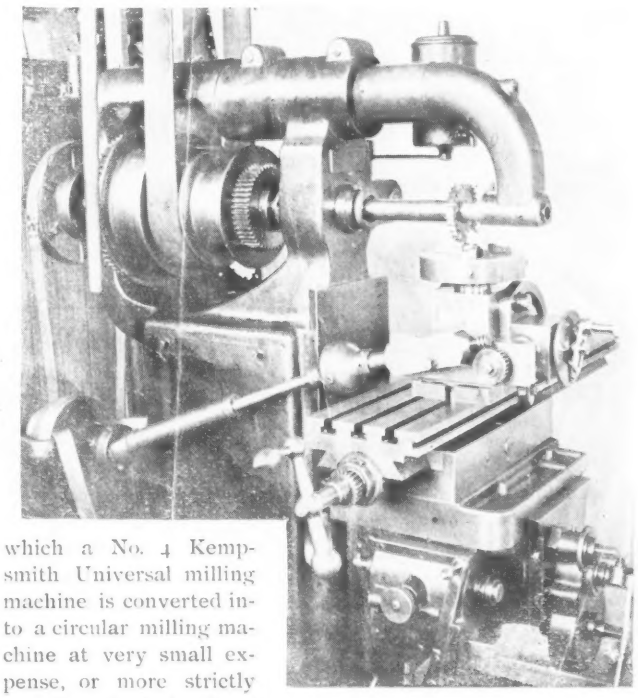
Where two supports or pairs of legs are necessary under a long frame, it is best to have them set a certain distance from the ends, and make the overhanging part of the frame of the parabolic form, as this divides up the bending movement and allows less deflection at the center. The sprawling, double-curved leg which originated in the time of Louis XIV., and which has served in turn for cabinets, tables, chairs, pianos, stoves and finally, engine lathes, has no claims either on the score of beauty or utility. It is incorrect in principle, is therefore ugly, and we should congratulate ourselves to see it gradually becoming an extinct species.

* * *

TWO NEAT SHOP DEVICES.

W. L. CHENEY.

A neat shop kink, designed by Fred C. Goss, foreman of the shop of the Meriden Machine Tool Co., of Meriden, Conn., by

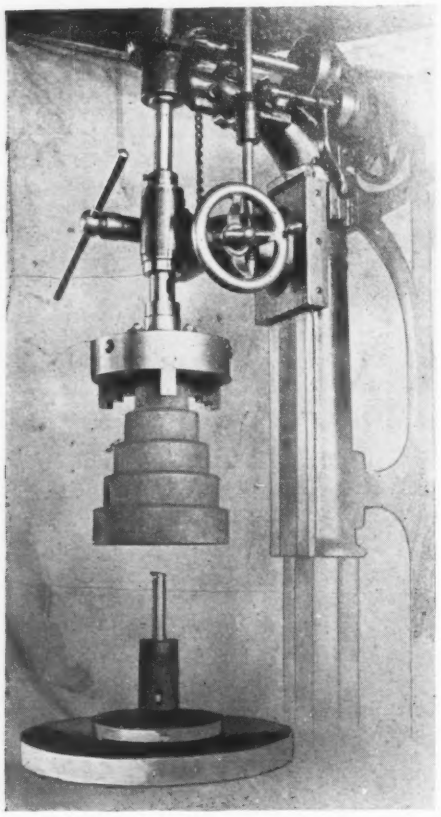


which a No. 4 Kempsmith Universal milling machine is converted into a circular milling machine at very small expense, or more strictly speaking, the index head is converted into a circular milling attachment, is shown in the

* From "Notes on Machine Design."

engraving (Fig. 1.) It will be seen that the change gear shaft of the index head carries a worm gear, and that a worm which is solid on the end of a shaft running in a simple box completes the outfit, unless the bolt that holds the box to the intermediate change gear yoke is counted as another piece. The universal joint hub is removed from its usual place on a shaft below (by simply driving out a pin), and is fastened by the same pin to the worm shaft mentioned above. The circular feed is started by letting the pin of the index handle drop into the first hole in the index plate that comes around and is stopped by withdrawing the same. The total expense of this kink is therefore what it costs to make the worm, worm gear, box and bolt.

Another useful, but more expensive, kink used in the same shop is shown in Fig. 2. The end of the drill press spindle is threaded same as the lathe spindles. Any chuck used in the shop will therefore go on the drill press spindle, and the drill press is shown set up ready to bore a cone pulley; the spindle is revolved and the cone trued up same as it would be in a lathe or any boring machine; the tools, whether drills, reamers or a boring tool, as shown in the engraving, are held in the flanged piece fastened to the drill press table. This flanged piece is bored No. 4 Morse taper, and the tools are removed with a drift in the slot, same as they would be from any taper socket. Of course the cutter of the boring tool is adjustable in order to set for the diameter required.



It is not claimed that this is a better way to bore pulleys than in a lathe or boring mill, but it often gives a chance to get a job of boring done that would need otherwise to wait for a lathe or boring mill in use at the time on some other job. It will be seen in the engraving that the drill press has a power feed and quick return, so that it takes no longer to bore a hole than it would in a lathe or boring mill, nor is it any harder for the machinist, and an incidental advantage is that the chips drop out of the way, and do not clog or grind the tools.

* * *

SOME PECULIARITIES OF STEEL.

A well known master mechanic recently said in speaking about boiler and fire-box steel, that in nearly every case of fracture, where the broken section would look as poor as cast iron, a test strip taken out right beside the fracture would show the same strength as when new, and yet the fracture appears rotten. He said that theories were many, but explanations few in regard to it. He also expressed the belief that if boilers could be put in an annealing oven every five years and thoroughly heated, then cooled slowly, so as to take out all the temper, the same as is done with lifting chains, they would be safer and last longer. Can any one explain the first peculiarities, and has the other suggestion ever been tested? Anything that will tend to make boilers safer should at least be given a trial.

* * *

We wish to call attention to a slight typographical error in the formula in Mr. Allen's article in the November issue. On page 7 $F_1=(r\times \not{p}\, r)$ should be $F_1=(r+r\not{p})$, and further down, $Fn=(r+\not{p}\, r)$, etc., should be $Fn=n(r+\not{p}\, r)$, etc.

TWO REPAIR JOBS.

James C. Hobart.

We all know the story of the owner of steam plant who had an acquaintance repair his pump, the actual work occupying only a few hours, and on receiving a bill for $50.00 he objected to paying the overcharge, whereupon the workman sat down and corrected the bill, as follows:

To repairing steam pump:

Labor, 3 hrs. at 50c..	$1.50
Knowing how.....	48.50
	$50.00

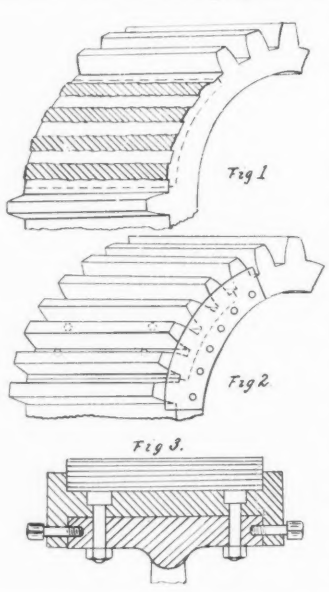
The owner paid it.

While it is hardly possible to-day to procure the above percentage of profit for the "know how," the following account of two cases of somewhat difficult repairing may prove interesting and perhaps valuable to some.

A steel rope in a cable driving station got between the steel driving pinion and a 14-foot differential cast gear, resulting in the stripping of four teeth in one place, three in another and one in a third from the gear.

The preponderance of advice was in favor of a new gear, but as this required time, which meant money, and as a gear of this kind is rather expensive, it was decided to attempt patching it. The circumferential pitch was 4 inches and the face about 16 inches, as I recollect it, and the pitch diameter 14 feet, as above stated.

The four-tooth break had something of the appearance shown in Fig. 1. A recess was first chipped the width of the face 1 inch deep at the edges, and the bottom of which was a chord of the circle, shown by dotted lines. A wooden templet of this recess was made and also of the four teeth adjacent to the break These teeth were selected in order that had there, for any cause, been unequal wear on this side the new teeth would be as nearly as possible like the old. A pattern was then made from this templet and a casting (phosphor bronze) with half shrouded teeth procured. The shrouds projected beyond the teeth in the direction of the circumference one and one-half times the length of the patch. The shrinkage was calculated from the center of the pattern, and so closely did the result agree with the calculations that only filing sufficient to remove the sand was necessary in order to make the casting of the teeth match the templet. The casting was fitted to the recess cut in gear and the shrouds were fitted closely on the two sides. Nine holes were then drilled through the shrouds on each side and tapped in the gear, and six holes were drilled through the patch and gear from the bottom of space between teeth, these latter were counter-bored and 1¼ inch fillister head bolts used to draw patch down solid and 1¼ inch hexagon head-cap screws were used on the sides. All bolts were finally removed before being sent home, and heated, the shrinkage not only drawing patch in solid, but causing the bolts to bind fast as well.



The other two patches only differ in detail, and further description is unnecessary.

The long ears of the shrouds resist any tendency to raise the patch. No difference in sound when the patches passed the pinion was perceptible on first starting up, nor has it ever been possible to take up any of the bolts, although it has been attempted many times in the past two years in which the gears have been in regular operation.

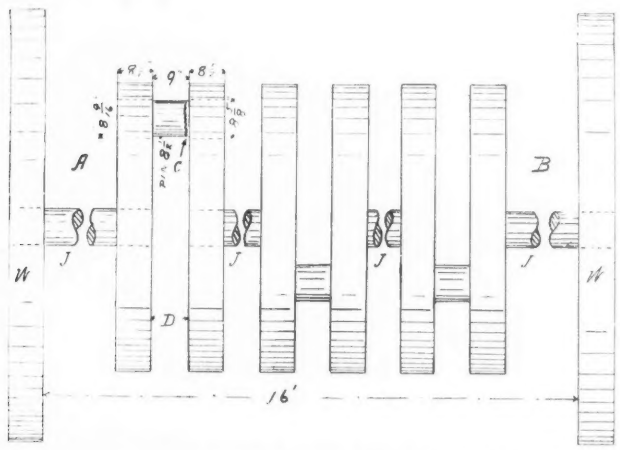
Were it not for the projection of the shrouds on the sides, it would be difficult to find the patches without close examination.

The other case alluded to was the repairing of a broken wrist-pin in a triple-throw crank shaft. The engine was of 750 horse power capacity of the vertical three cylinder type. The crank-shaft was of steel built up, that is, cast-steel crank discs were pressed on straight sections of shaft and the wrist-pins pressed into the discs. Weights aggregating several thousand pounds were carried on each end of shaft unsupported by outboard bearings, denoted by W W.

Owing to the construction of the engines it was impossible to remove the shaft without taking down the cylinders and frame supports for same. The great difficulty encountered here was to so line the shaft in its position in engine that a new pin could be put in with any degree of truth.

It was absolutely essential that the engine run at the earliest possible date, otherwise probably no other plan, not including the removal of the shaft from the engine and the placing of same in centers, would have been considered. Under the circumstances, however, a day and night force were set to work to put in a new pin with the shaft in position. The accompanying sketch will indicate the nature of the construction and the break.

The first thing to be done was to drill out the broken pin. Owing to the proximity of the housing on one side nothing could be used there but a hand ratchet for drilling the other side, and for subsequent boring a portable drill was clamped to disc and driven



Engine frame fills spaces A and B. Parallel blocks placed at D and discs drawn together by heavy clamps. Journals J J. Weights W W. Break at C.

by a small motor. After the broken pin was removed, the bearing caps were taken off and the two parts of the shaft raised until they were perfectly level, and parallel blocks placed (symmetrically spaced) between the now disconnected crank discs and these discs, which were turned the same diameter, centered by laying a straight edge across the two faces and adjusting shaft until it bore the full width of both faces at all points around the disc. The wrist pin holes had of course been kept opposite each other, and when the discs were properly centered they were solidly clamped on the parallel blocks. A travelling head-bar was run through both pin-holes with bearings rigidly clamped to the discs. This bar was also driven by the motor, and the two holes were bored true and in line, as shown by the dotted lines on sketch. A hammered steel pin was made with ends turned slightly larger than the respective holes they were to enter. Charcoal fires were built in the pin-holes, and the pin itself, which weighed 500 pounds, supported on a chain block in line with the holes. The holes were constantly calipered to gauge the expansion, and just as the metal began changing color they were cleaned out, the pin shoved home and a few brisk blows from a sledge completed the most difficult part of the work. Upon replacing the caps and starting the engine, the shaft was found to run perfectly true. Six days were required for this work from the time of starting to the time of running the engine, which also included one day's delay in procuring the necessary steel for the new pin.

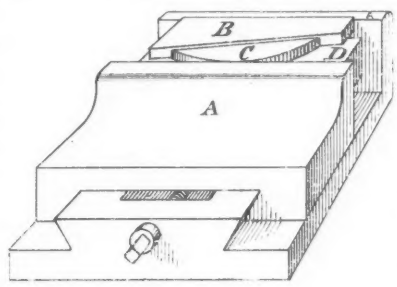
* MACHINE SHOP WORK.

SOME EXAMPLES OF MODERN PRACTICE.

JOHN T. USHER.

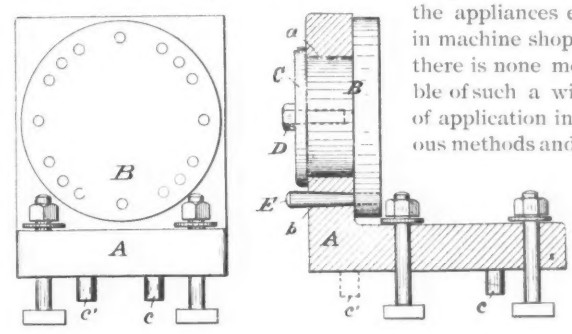
CHUCKING TAPER WORK.

The method of holding taper work shown in Fig. 1 is very simple and may be used for holding work of any taper. The work is held by means of a semi-circular chucking piece interposed between the sliding jaw of the chuck and the work, A A representing the chuck, B the work, C semi-circular chucking piece, D parallel placed under the work to act as a support and to align it horizontally. A similar semi-circular chucking piece may be employed for holding taper work in the vise while it is being fitted, and will be found to be as handy as any tool the vice workman possesses.



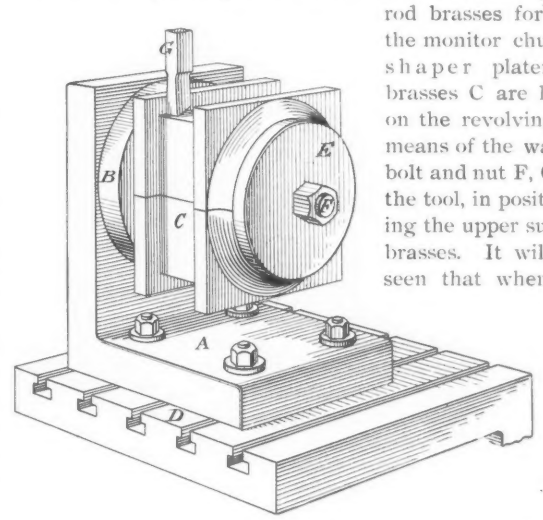
MONITOR CHUCK.

The monitor chuck shown in the engraving may justly be regarded as the *ne plus ultra* of chucking devices. For of all the appliances employed in machine shop practice there is none more capable of such a wide range of application in the various methods and processes than this is. The illustrations shown represent a front and side elevation (partly in section) of the chuck. The angle plate A is bored at *a* to receive the revolving chucking plate B, which is held by the washer C and the binding screw D. The work is clamped to the chucking plate B in such manner that on revolving, the chucking plate and work, each surface to be operated on, can be brought into position in succession for the operation. The angles at which the different parts of the work are presented is predetermined by means of the index pin E, which is inserted in the angle plate A at *b* and in the index holes of the chucking plate B; the holes in the latter being spaced according to the number and position of the surfaces and parts on the work to be operated on.



PLANING CONNECTING ROD BRASSES ON THE MONITOR CHUCK.

The next engraving shows the method of chucking connecting rod brasses for planing on the monitor chuck A B and shaper platen D. The brasses C are held in place on the revolving plate B by means of the washer E and bolt and nut F, G represents the tool, in position for planing the upper surfaces of the brasses. It will be plainly seen that when the upper surfaces of the brasses have been planed, if the plate B and work is given a quarter turn; the next side of the brasses will be brought into position ready for planing, as already explained, and so on until the brasses are finished.



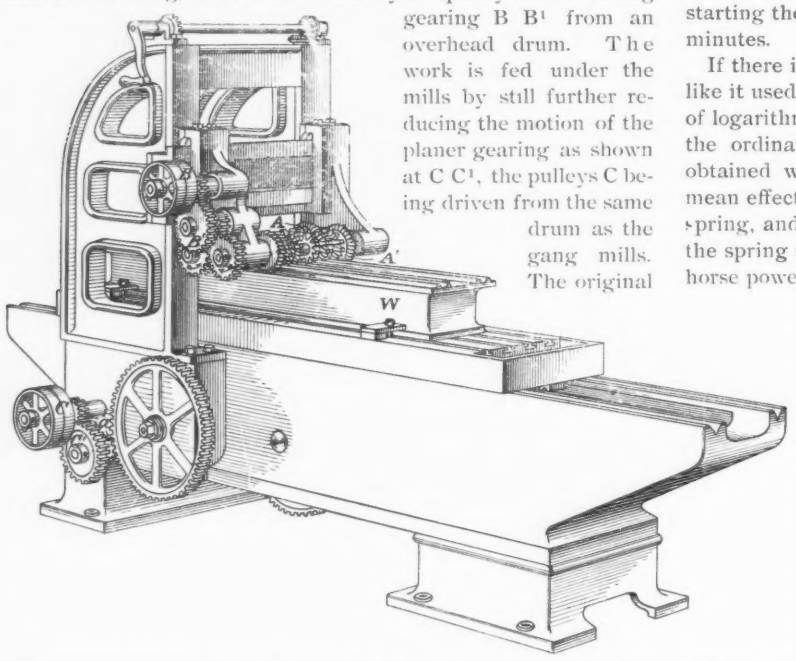
The rod brasses can be turned and bored by strapping them to

* (Copyright 1894, John T. Usher.)

the revolving plate, the whole chuck being bolted to the face plate of the lathe. This will only require two operations for planing, boring and turning, and two chuckings instead of four for planing, and two for boring as usually done.

DOUBLE GANG MILLING.

One of the most striking examples of modern milling machine work that we have ever seen is the method employed by Mr. Garland for milling the shears and upper surfaces of lathe beds at one operation, as shown in the engraving, which represents a lathe bed W, chucked in the ordinary way on the planer, which was converted into a milling machine having two sets of gang mills A A^1 in operation at the same time: one set for roughing and the other for finishing, driven as shown by the pulleys and reducing gearing B B^1 from an overhead drum. The work is fed under the mills by still further reducing the motion of the planer gearing as shown at C C^1, the pulleys C being driven from the same drum as the gang mills. The original



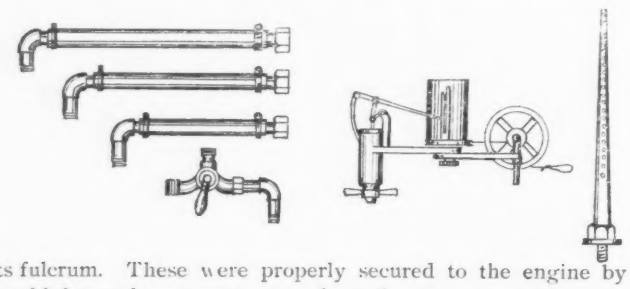
quick return motion of the planer is fully retained by arranging the belt shippers in such manner that when the work is being fed under the cutters the original belt is running on the loose pulley or else stopped altogether, and when the motion of the platen is reversed, the pinion *a* is thrown out of gear, the feed belt shipped onto the loose pulley, and the original belt onto the tight pulley. The mills are run one set over and the other set under, or as it is sometimes termed, "on and off" the work, as indicated by the arrows on the gears.

* * *

OLD AND NEW METHODS WITH THE INDICATOR.

EDWARD J. WILLIS, M. E.

Some years back indicating an engine was pretty much a two days' job. First, as indicating was not usual with all builders, a machinist frequently had to be called in to tap the cylinder, and to get rid of the chips the heads had to be removed. Next a pipefitter came along and piped the cylinder. Then a blacksmith was called in and forged an arm and link and probably a bracket for



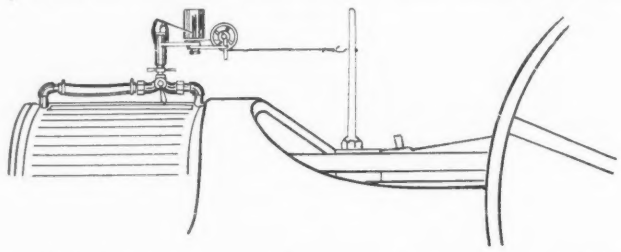
its fulcrum. These were properly secured to the engine by a machinist, and a carpenter sawed out the segment. After selecting the spring, setting up the indicator and attaching cord, the cards were taken. The cards were then taken to the drawing-room and the tedious processes of calculating the horse power by ordinates gone through with. It was looked upon as good time if the engine was not stopped over half a day and the result reported within forty-eight hours.

Let us compare this with later methods. For rapid work the following would probably be best suited. First, the indicator with attached reducing wheel, as shown in cut. Second, the three-way cock with elbow and three or four short pieces of five-ply half inch steam hose with elbow and union piece attached as shown, and last the drilled standard. A monkey-wrench, a brace, a $\frac{7}{16}$ drill and a half inch hob tap will be all the tools called for. The cross-head is first drilled and tapped and the standard screwed in. The plugs are then removed and the three-way cock screwed into rod end of cylinder. That piece of steam hose is selected which comes nearest the cylinder length, and its elbow screwed into head end of cylinder and its union connection made tight onto the three-way cock. The proper spring is put in indicator and the proper bushing put on reducing wheel. The cord is run forward to hole in standard, which comes level with bottom of reducing wheel and the card is taken. If the indicator and reducing wheel are set up for engine before starting there is no reason why the job should take over fifteen minutes.

If there is no planimeter available calculating the card is about like it used to be, except that to any one acquainted with the use of logarithms the work is greatly expedited by their use. With the ordinary planimeter the mean effective pressure can be obtained without much figuring. Other planimeters will give mean effective pressure as if card were taken with a forty pound spring, and a correction is applied to reduce reading to that of the spring used. After obtaining the mean effective pressure the horse power is only a matter of multiplication and long division.

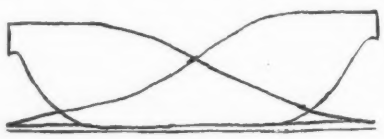
The writer has lately patented a planimeter which will read mean effective pressure and horse power direct from the card without calculation of any kind. Provided with the attachments shown in cut and this direct reading planimeter, the writer has frequently attached, indicated and reported the horse power of an engine inside of fifteen minutes, and there is no reason why any one familiar with the work and instrument should take a great deal longer.

It would at first sight appear that the steam hose connection would be objectionable and cause inaccurate cards. It will, however, be noted that the hose in the same bore and practically the same length as the half-inch pipe usually employed when one indicator is used. By selecting the shortest length of hose which will reach the union, there should not be over two or three inches



more hose than there would be steam pipe. In some instances, on account of the rectangular piping necessitated around the throttle, there is really less hose than there would be pipe. For some years the writer has used this method and has never noticed any difference between the cards taken through the hose and those taken through pipe. The only trouble met with has been that with new hose the steam carries a black gum over to the piston and fouls it badly.

In connection with attaching the indicator there occurs an effect on the card which may have passed unnoticed, or if noticed unexplained. Sometimes cards have hooks or beaks at the end of compression somewhat as shown in card herewith. This is due to the engine piston closing the indicator ports at each end of the stroke, and the only remedy is to cape out well from holes into counterboring. It would seem pretty hard to explain the hooks by valve action, but in one instance a party had it so thoroughly explained to his own satisfaction that only by caping out into the counterboring before him was it possible to prove that this was the cause.



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The Manufacturers Association, of Cincinnati and Hamilton County, Ohio, have issued a call for a meeting in Cincinnati on Jan. 22d, 1895, to form a National Association to consider, among other things, the plan of holding exhibitions in South American cities to further trade relations with the United States.

THE SLIDE RULE IN THE SHOP.—(2.)

WILLIAM COX.

It is now necessary that we should examine the two top scales A and B. The first thing that strikes us is that the graduations are closer together and that they both consist of two scales in succession, each one being consequently exactly half the length of the scales C and B.

If we set the slide so that its indices coincide with those of the rule, and assign to all the left indices the value of 1, then, as explained, the right index of C and D will have the value of 10. Taking the left upper scales A and B, and proceeding towards the right from the left, we have 1, 2, 3 . . . and 10 in the middle of the instrument, which is called the middle index; then taking the right upper scales, and remembering that the value of their left indices is 10, we have 10, 20, 30 . . . and 100 as the value of the right hand index. Now 100 is the square of 10, which is the value at present assigned to the right index of C and D. Likewise if we take any other numbers on the lower scale, as 2, 3 4, etc., we find above them on the upper scales, and coinciding with them their squares 4, 9, 16, etc., so that the values of the upper scales are the squares of the values of the lower scales, and inversely, the values of the lower scales are the square roots of those of the upper scales. A small sliding brass runner is provided which enables coinciding graduations on the different scales to be read off.

The fact of this relationship of squares and square roots must be particularly borne in mind when solving any problem involving these quantities. Thus, if we assign the value of 10 to the left index of C and D, the value of the left index of A and B will be necessarily 100 and not 10; and the right index of A and B will be 10,000, which is the square of 100, which in this case is the value of the right index of C and D. Again, if I wish to obtain the square root of 4, I take the left scale of A or B; if of of 40, the figure 4 in the right scale of A or B; and if of 400, the figure 4 in the left upper scale of A or B. Hence we see that when the two upper and the two lower scales are being used together in the solution of a problem, that the value of 10 or 1,000 can never be assigned to the left index of A and B, but always 1, 100, 10,000, 0.01 or 0.0001, whilst 10, 1,000, 0.1 or 0.001 are possible values of the middle index of A and B. I have known many persons get entangled in their work because they overlooked this relationship existing between the two pairs of scales, and yet a little thinking and reasoning out of the matter will make it quite clear.

One more hint before proceeding to some practical examples. When locating a number on the slide rule, or reading off the value of a given graduation, or the decimal subdivision of a space between two graduations, it will be found better to take in the mind not the numerical value of the number, but the sequence of the figures. Thus instead of saying mentally "Two hundred and sixty-four," say "Two-six-four," by this means directing the eye to first find the figured graduation 2, then the primary subdivision 6, and afterwards the second subdivision 4. To this graduation thus found, its real value is now assigned, which may be 264, 26.4. 2640, etc. It must also be remembered that it is not necessary that the same value be assigned to both A and B, or C and D, as it may, for instance, be desired to use the ratio 2 to 40 on scales C and D by putting 2 on C over 40 on D, in which case the value assigned to the left index of C is 1, while that of D is 10. Now if it is desired to find the number having the same ratio to 35 that 40 has to 2, or the proportion 2 : 40=35 : 700, it is necessary to mentally alter the value of the left slide index C, making it 10, and likewise the left rule index D, making it 100 to correspond, so that we then have 35 on the slide and 700 on the rule beneath it, the whole diagrammatically shown thus:

C...	Set 2	Below 35
D...	Over 40.	Find 700.

It is rare that this assigning of values to the indices is really done, the required figures being merely found and the nature of the problem indicating, as it generally does. in a sufficient measure about what the answer should be. This exact method, which it would nevertheless be well to practice a little, serves, however, to show the advantage of reading the figures in sequence, the above two ratios reading 2 to 4—0 for the first and 3—5 to 7—0—0 for the second; all which goes to prove that with the slide rule we deal with figures and not with numbers. If several scales could be joined on one to the other, this process would not be necessary, as real and distinct values could be given to every graduation, but then the instrument would lose one of its chief merits, namely, its extreme portability.

PROBLEMS IN SIMPLE PROPORTION.

The method just illustrated of showing a proportion diagrammatically is a very useful one, as by means of such ratios or equivalents a variety of problems can be very quickly and easily solved. Thus, suppose that instead of the ratio 2 to 40, where 2 on scale C of the slide is set over 40 on scale D of the rule, we take the ratio 226 to 710, setting 226 on scale C over, or coinciding with, 710 on scale D. This is the first ratio of the proportion. Let now 12 be the third term of the proportion, then under 12 on scale C we find 37.7 on scale D, which is the fourth term, so that

$$\frac{226}{710} = \frac{12}{37.7}$$

Now 226 to 710 is the ratio of the diameter of a circle to its circumference, therefore 12 to 37.7 must be ratio of the diameter of another circle to its circumference, and similarly with any other diameter taken on scale C, its equivalent circumference will be found on scale D, so that we have

C...	Set 226	Under any diameter
D...	Over 710	Find corresponding circumference.

It may be said in passing that the ratio 226 to 710 is more exact than the commonly used one, 1 to 3.1416, seeing that 226 to 710=1 to 3.1415929 . . . , while the exact ratio is 1 to 3.1415926 . . . , the difference 0.0000003 being absolutely inappreciable. The ratio of 226 to 710 is therefore called the equivalent of the diameter and circumference of a circle, and as there are on the slide rule distinct graduations of the scales for the figures 226 and 710, it is much easier to set off this ratio than 1 to 3.1416, where the exact position of 0.0016 would have to be guessed or *estimated*.

If it should now be required to find the circumference of a circle whose diameter is, say, 6 inches, this cannot be done as the slide stands, seeing that 6 of the slide is beyond the rule, and has therefore no corresponding figure underneath it on scale D. The method is therefore to bring the runner so that it coincides exactly with the left index of the slide, then push the slide inwards to the left until its right index coincides with the runner, when under 6 on scale C will be found 18.85 on scale D, which is the required circumference. Similarly if the circumference is given and it is required to find the corresponding diameter, take the circumference on scale D, then over it on scale C, and coinciding with it, will be found the diameter.

The following equivalents, which should be used in precisely the same manner with scales C and D, will be often found useful:

$$\frac{79}{70} = \frac{\text{Diameter of a circle}}{\text{Side of equal square.}}$$

$$\frac{99}{70} = \frac{\text{Diameter of a circle}}{\text{Side of inscribed square.}}$$

$$\frac{70}{99} = \frac{\text{Side of a square}}{\text{Diagonal of square.}}$$

$$\frac{322}{205} = \frac{\text{Area of a circle}}{\text{Area of inscribed square.}}$$

$$\frac{38}{25} = \frac{\text{Side of equilateral triangle}}{\text{Side of equal square.}}$$

$$\frac{800}{107} = \frac{\text{U. S. gallons}}{\text{Cubic feet.}}$$

These equivalents will all be found to be within one per mille of the exact ratio, nearer than which the slide rule is not expected to go. Of course in every case both terms of the ratios must be taken in the same denomination, either inches or feet, etc.

The following equivalents involving the use of all the scales of the slide rule, will also be found useful:

A...	To 14	
B...	Set 11	Find area of circles
C...		
D..		Above diameter of circles.

which means that 11 of scale B of the slide must be set under 14 of scale A of the rule, then on the lower scale D of the rule we have a range of diameters of circles, the corresponding areas of which will be found by means of the runner on scale B of the slide. Thus, having set off the above ratio on scales A and B, if

we take the diameter 2 on scale D and bring the runner to it, we find over it, and corresponding to it, on scale B the value 3.14, which is the area of a circle whose diameter is 2.

A. .	To 30	
B... C...	Set 13	Find area of equilateral triangle
D. .		Over side of equilateral triangle.

To find the geometric mean of two numbers, the following is useful:

A. .	To one number	
B... C...	Set 1	Below other number
D. .		Find geometric mean.

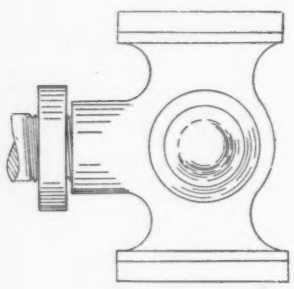
If these examples are carefully followed and the manner of working them out thoroughly mastered, the examples in practical mechanics which will be given in the next issue of MACHINERY will be easily understood and found of service both in the draughting-room and shop. Should any reader meet with any difficulty, if he will state it to the editors the writer will be very pleased to do his best to explain it away; if of mere personal interest, directly to the reader; but if of general interest, through the columns of this welcome monthly.

* * *

WHY SOME ENGINES POUND.

W. H. WAKEMAN.

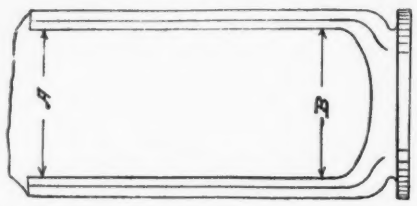
I know of no one who has been more perplexed than the engineer when his engine pounds and he cannot locate the cause of it. Sometimes it appears to be in the cross-head, again it is in the crank-pin, then it shifts to the eccentric, now appears to be in the cylinder, and at intervals it disappears altogether. The fact that it appears to shift from one place to another is because a noise made in one part telephones along the iron or steel of the other parts, and so sounds as if coming from different places. When a noise of this kind is heard a part of the time only, it is often more annoying than if heard constantly, and is much more difficult to locate, for if there is a cause for it during a part of the day, why should it not be there at all times?



A certain engineer, who was running a cross-compound engine, was troubled by a heavy pound in the low pressure cylinder. It was of the intermittent type, appearing during the first quarter of an hour that it was run in the morning, and then disappearing, only to reappear when the engine was again started after it had been shut down. It was a rather large engine, so that it required some labor to take it apart and put it together again; but persistent search was made for it until the efforts of the engineer were crowned with success.

It is well known that when large cylinders are cast in one piece they are liable to be fractured by unequal contraction and expansion. In order to prevent this, or at least to make repairs less expensive, they are sometimes made in two parts, one forming a lining for the other. In this particular case this lining was made one thirty-second of an inch too short, so that in the morning before the parts were thoroughly warmed up, this lining was loose and would move endwise until it struck a cylinder-head, thus causing the unwelcome noise. We believe that this engine was jacketed. After it had been running for a few minutes it would be held tightly in place, and there would be no more noise. It can readily be seen that when this lining was against the cylinder-head on the head end, when the engine was shut down, it was impossible to discover any defect when the head was off, for none existed at that end, and it could not be seen at the other. It was useless to remove the follower plate and examine the packing rings, or to remove the entire piston and look for defects under these conditions, for everything appeared to be in first-class order, but fortunately one day it happened to be stopped with the loose lining up tight against the cylinder head at the crank end and the the defect was discovered.

A short time ago our attention was called to an engine which ran quietly for some parts of the day, and would then pound heavily. This had continued for several days, but no determined effort had been made to discover the cause of the disturbance, until it was considered dangerous to run the machine any longer. The cylinder-head was then taken off and the follower wrench put on to one of the follower bolts in order to remove it, but when force was applied to this wrench the whole piston turned, together with the piston-rod. The piston-rod was screwed onto the cross-head and held there by a jam-nut. (See Fig. 1.) This nut had become loosened, allowing the rod to turn, and as the engine had been in use for several years, there was some lost motion in the threads, so that when the rod was started outward, even to the extent of a quarter of a turn, the engine would pound, and when it worked back into place the noise would disappear. It will readily be seen that if this had been unscrewed far enough, an expensive accident would have resulted.



Usually it is a comparatively easy matter to stop an engine from pounding when the exact cause is known, but the following is an exception to the rule. Take for illustration the case of a Corliss engine or any other which has a similar form of guides. (See Fig. 2.) When the engine is built, these guides are planed so that the distances at A and B are the same, which of course is proper. These guides are bolted to, or perhaps are cast in one piece with the cylinder-head, and when the machine is in operation the heat of the steam causes expansion so that the distance at B becomes greater than at A. Now the cross-head must be adjusted to the narrowest part of these guides, or else it will heat and cut, so that it becomes necessary to place the engine on or near the outside center, by which we mean the piston-rod as far out of the cylinder as possible, adjust the cross-head there and let it go where it will during the remainder of the stroke. If the engine runs "over," or in other words if the top of the fly-wheel revolves from the cylinder, there will be no pound, because the pressure is all downward on the guides and everything runs smoothly, but if it was planned for and erected by some one who unfortunately believed that it would be just as well to run it in the opposite direction, then we may expect trouble, for while the weight of the parts press downward, the thrust of the connecting-rod raises the cross-head, and thus sometimes causes a bad pound. The writer once had charge of an engine that was built and run in this way, and we are free to admit that we exhausted our ingenuity in endeavors to dispose of that soul-tormenting and wrath-provoking pound, but without success. We are aware that there are some engines running in this way that do not pound, and for this the engineers in charge are to be congratulated, but if an engine does pound from this cause, it is well nigh impossible to stop it in any practical way.

If the piston packing ring is made in one piece and sprung into a groove in the bull-ring, it is almost always a good fit, and consequently does not bind anywhere, but where there are packing rings on each side of the bull-ring, which are supposed to be made so that they will just fill a space between the spider and the bull-ring on one side, and the bull-ring and the follower plate on the other, but if the rings are made a trifle thicker than they should be, even if it is no more than one sixty-fourth of an inch, they will be prevented from working freely, and will probably cause a pound.

This is one of the causes which does not appear on the surface, for the engineer may take the packing out and examine it thoroughly and find nothing that will cause him to suspect that there is any defect in them, and so put them together again, only to discover next morning that the same old pound is present, and ready and willing to be heard. The proper way to do is to take the whole piston, together with the rod, out of the cylinder and put it on the bench. Then put all of the parts in place, just as if they were in the cylinder, taking care to screw the follower bolts up tightly, and note if the rings have room to work freely. If not the defect must be remedied, and at the same time care must be taken not to make them too loose.

* * *

Plan your shop so as to avoid rehandling of material, and let each successive process be done as it passes through the building.

WHAT MECHANICS THINK.

THIS COLUMN IS OPEN FOR THE EXPRESSION OF PRACTICAL IDEAS OF INTEREST, TECHNICAL OR OTHERWISE. WRITE ON ONE SIDE OF THE PAPER ONLY, AND BOIL IT DOWN.

WHEN SKETCHES ARE NECESSARY TO ILLUSTRATE THE IDEA, SEND THEM ALONG—NO MATTER HOW ROUGH THEY MAY BE, WE WILL SEE THAT THEY ARE PROPERLY REPRODUCED.

TABLE OF CUTTING SPEEDS.

Feet per Minute.	5′	10′	15′	20′	25′	30′	35′	40′	45′	50′
Diam.	REVOLUTIONS PER MINUTE.									
1/2	38.2	76.4	114.6	152.9	191.1	229.3	267.5	305.7	344.0	382.2
5/8	30.6	61.2	91.8	122.5	153.1	183.7	214.3	244.9	275.5	306.1
3/4	25.4	50.8	76.3	101.7	127.1	152.5	178.0	203.4	228.8	254.2
7/8	21.8	43.6	65.5	87.3	109.1	130.9	152.7	174.5	196.3	218.9
1	19.1	38.2	57.3	76.4	95.5	114.6	133.8	152.9	172.0	191.1
1 1/8	17.0	34.0	51.0	68.0	85.0	102.0	119 0	136.0	153.0	170.0
1 1/4	15.3	30.6	45.8	61.2	76.3	91.8	106.9	122.5	137.4	153.1
1 3/8	13.9	27.8	41.7	55.6	69.5	83.3	97.2	111.1	125.0	138.9
1 1/2	12.7	25.4	38.2	50.8	63.7	76.3	89.2	101.7	114.6	127.1
1 5/8	11.8	23.5	35.0	47.0	58.8	70.5	82.2	93.9	105.7	117.4
1 3/4	10.9	21.8	32.7	43.6	54.5	65.5	76.4	87.3	98.2	109.1
1 7/8	10.2	20.4	30.6	40.7	50.9	61.1	71.3	81.5	91.9	101.9
2	9.6	19.1	28.7	38.2	47.8	57.3	66.9	76.4	86.0	95.5
2 1/4	8.5	17.0	25.4	34.0	42.4	51.0	59.4	68.0	76.2	85.0
2 1/2	7.6	15.3	22.9	30.6	38.2	45.8	53.5	61.2	68.8	76.3
2 3/4	6.9	13 9	20.8	27.8	34.7	41.7	48.6	55.6	62.5	69.5
3	6.4	12.7	19.1	25.5	31.8	38.2	44.6	51.0	57.3	63.7
3 1/2	5.5	10.9	16.4	21.8	27.3	32.7	38.2	43.6	49.1	54.5
4	4.8	9.6	14.3	19.1	23.9	28.7	33.4	38 2	43.0	47.8
4 1/2	4.2	8.5	12.7	16.9	21.2	25.4	29.6	34.0	38.1	42.4
5	3.8	7.6	11.5	15.3	19.1	22.9	26.7	30.6	34.4	38.2
5 1/2	3.5	6.9	10.4	13.9	17.4	20.8	24.3	27.8	31.3	34.7
6	3.2	6.4	9.6	12.7	15.9	19.1	22.3	25.5	28.7	31.8
7	2.7	5.5	8.1	10.9	13.6	16.4	19.1	21.8	24.6	27.3
8	2.4	4.8	7.2	9.6	11.9	14.3	16.7	19.1	21.1	23.9
9	2.1	4.2	6.4	8.5	10.6	12.7	14.9	17.0	19.1	21.2
10	1.9	3.8	5.7	7.6	9.6	11.5	13.4	15 3	17.2	19.1
11	1.7	3.5	5.2	6.9	8.7	10.4	12.2	13.9	15.6	17.4
12	1.6	3.2	4.8	6.4	8.0	9.6	11.1	12.7	14.3	15.9
13	1.5	2.9	4.4	5.9	7.3	8.8	10.3	11.8	13.2	14.7
14	1.4	2.7	4.1	5.5	6.8	8.1	9.6	10.9	12.3	13.6
15	1.3	2.5	3.8	5.1	6.4	7.6	8.9	10.2	11.5	12.7
16	1.2	2.4	3.6	4.8	6.0	7.2	8.4	9.6	10.7	11.9
17	1.1	2.2	3.4	4.5	5.6	6.7	7.9	9.0	10.1	11.2
18	1.1	2.1	3.2	4.2	5.3	6.4	7.4	8.5	9.6	10.6
19	1.0	2.0	3.0	4.0	5.0	6.0	7.0	8.0	9.1	10.1
20	1.0	1.9	2.9	3.8	4.8	5.7	6.7	7.6	8.6	9.6
21	.9	1.8	2.7	3.6	4.5	5.5	6.4	7.3	8.1	9.1
22	.9	1.7	2.6	3.5	4.3	5.2	6.1	6.9	7.8	8.7
23	.8	1.7	2.5	3.3	4.1	5.0	5.8	6.6	7.5	8.3
24	.8	1.6	2.4	3.2	4.0	4.8	5.6	6.4	7.2	8.0
25	.8	1.5	2.3	3 1	3.8	4.6	5 3	6.1	6.9	7.6
26	.7	1.5	2.2	2.9	3.7	4.4	5.1	5.9	6.6	7.3
27	.7	1.4	2.1	2.8	3.5	4.2	5.0	5.7	6.4	7.1
28	.7	1.4	2.0	2.7	3.4	4.1	4.8	5.5	6.1	6.8
29	.7	1.3	2.0	2.6	3.3	4.0	4.6	5.3	5.9	6.6
30	.6	1.3	1.9	2.5	3.2	3.8	4.5	5.1	5.7	6.4

Computed by Beaman & Smith, Providence, R. I.

The above table is a convenient one for finding the number of revolutions per minute required to give a periphery speed from 5 to 50 feet per minute of diameters from ½ inch to 30 inches.

EXAMPLES.—A mill of 2 inches diameter to have a periphery speed of 35 feet per minute, should make about 67 revolutions, while a 1⅛ inch mill should make 120 revolutions to have the same periphery speed. If a ¾ inch mill makes 250 revolutions per minute, the periphery speed is about 50 feet.

In a recent article by one of your associate editors, Mr. W. L. Cheney, in reference to milling machine feed, speeds, etc., adds a short table of diameters with the corresponding speed for 35 feet per minute. To us we found such a table very useful, and therefore prepared one giving diameters from ½ inch to 30 inches inclusive, to run from 5 feet to 50 feet per minute inclusive. This table we also found useful for lathe work, boring machines, chucking machines, etc.; in fact, revolving work of any kind to be cut by tools.

This table as herein shown forms page 47 of our catalogue C, and will be sent gratuitously to any of your readers who may desire a copy. BEAMAN & SMITH.

GEAR PITCHES AND SCREW THREADS.

These are very puzzling to apprentices and even older men, unless they have studied them carefully, and the fact that two methods of giving each pitch are in use helps to mix the boys up. In our shop we use "diametral pitch" for gears and "threads to inch" for screw threads, the former being the number of teeth *per inch of diameter*, and the latter needs no explanation. A gear 3 inches in diameter at pitch line having 30 teeth would be 10 pitch, *i. e.*, 10 teeth for every inch in diameter. But now go to Brown's shop and see what he does. You find drawings of gears marked "½ inch pitch," measuring the distance between centers of the teeth *on pitch line*, and is harder to measure on a gear than the diametral pitch. Then you find threads marked ".20 inch pitch," meaning that from center to center of thread is .20 of an inch, or 5 to the inch. The advantage of Brown's gear method is confined to large gears, and the same may be said of his thread measurement, if it has any advantage.

If the two methods of gear measurement are to be used, the limit should be made known in every shop and measurements governed thereby. Why not adopt the plan of using diametral pitch until 1 is reached, then circumferential pitch? For example, a gear 40 inches in diameter (on pitch line, of course), having 60 teeth, would be 1½ pitch; having 40 teeth would be 1 pitch, and having 30 teeth would be measured as Brown does.

The same might be said of threads, if the threads to inch are not satisfactory for coarse, heavy work. WHYNOT.

A CORRECTION—HANDY FORMULA.

On page 6 of October MACHINERY you give two formulas for the shop and drawing-room, with an example referring to the length of sheet metal to enclose a box 2 feet square, the solution of which is not, I think, quite correct, as I make

$$C=\frac{24}{0.225079}=106.63 \text{ nearly.}$$

I take the liberty of submitting the following, which are very easily remembered, and being practically correct, are specially useful for slide-rule practice:

$$S=D\times\frac{70}{99} \text{ and } S=C\times\frac{9}{40}$$

which transposed give

$$D=S\frac{99}{70} \text{ and } C=S\frac{40}{9}$$

For the slide rule I should give them in this form:

$$\frac{99}{70}=\frac{\text{Diameter of circle}}{\text{Side of inscribed square}} \text{ and } \frac{40}{9}=\frac{\text{Circumference of circle.}}{\text{Side of inscribed square.}}$$

By this method above example works out to 106.66, and with the slide rule to 106.6, which is very near the exact figure.

WM. COX.

[NOTE.—S=side of incribed square. D=diameter of circle C=circumference of circle.—ED.]

A PLANER DEVICE,

Probably any one that has run a planer any great amount has at some time had occasion to plane a spot, or keyway, shorter than the shortest travel of the table, and no doubt many of the older planer hands know of many simple ways of doing it. But I will give you one very easy way of doing it for what it is worth to those who are not "onto" it. It can be accomplished as follows: Adjust the dog to stop the table at the desired point on the forward or cutting stroke, and bring the other dog as near it as possible, and then clamp a block of wood in such position that the tool will strike it on the return or backward stroke, and lift it up when the cutting edge comes to the rear end of the spot to be planed, and drag over the corner until the dog shifts the table, care being taken not to let the end of the tool get onto the top of the block.

Most planers will shift very close to a line when shifting from forward to backward stroke, but very few will shift nearer than one-half inch when shifting from backward to forward stroke, and I have known planers that would vary two inches or more.

Recently I had a chance to test the merits of the above scheme. I had a large shaper saddle to plane, and when I came to recess it on the under side so as to bring the bearing on the shears at either end I found the planer shifted close enough at one end, but the other end looked like a very dilapidated picket fence. I just clamped on a piece of board to raise the tool a little at the rear end and the cut started just as it stopped. SPIKE.

EXPENSIVE NEGLIGENCE.

Too little attention is paid to putting up belts and the consequences if they happen to run off the pulleys, the neglect often being costly and dangerous. Two pulleys were so close together that if either belt slipped in between it was sure to catch, and then something had to give. A new belt was put on and the tool in the lathe caught in the work, the belt slipped in between, caught, pulled down the countershaft, the lathesman narrowly escaping with his life, and a torn belt, bent and broken countershaft was the result, beside being deprived of the use of the lathe till repairs were made. It took two men a day to get it straightened out, and then the foreman had it *put back the same as before with no safeguard whatever*. The second day the accident was repeated, and even then it took persuasion and suggestive hints to get him to put a guard between the pulleys so

that the belts could not possibly slip between. This shop is always preaching hard times and poverty, and judging from the above sample of shop management they have reason to.

LATHESMAN.

* * *

MANUFACTURING NOTES.

HOWARD CHALLEN, 10 Spruce Street, City, has favored us with one of his "Engineers Log Books," by which a complete record of a steam plant is very easily kept.

THE steam gages used on the "Oregon" (described in our November issue) were furnished by the Star Brass Co., of Boston, who also supplied those used on the steam yacht "Eleanor."

THE D. A. WHITON MACHINE CO., of New London, have issued a catalog of their new Automatic Gear Cutting Machine, which describes a very complete machine with many valuable features.

FRANCIS W. CLOUGH, of Springfield. Mass., well known as a designer and maker of special tools, has issued a neat 16 page catalog of his specialties, which will interest draughtsmen and machinists.

MODERN METHODS OF HANDLING FUEL is a very interesting booklet by the Link Belt Machinery Co., of Chicago, showing their latest work in this line, which will be valuable to wide-awake engineers and managers.

THE catalog of the Olin Gas Engine Co., Buffalo, gives information which power users and those interested in gas engines will find useful. The economy claimed makes it a strong competitor of the steam engine.

THE LUNKENHEIMER CO,, of Cincinnati, O., have taken time by the forelock and issued a very neat and comprehensive catalog for 1895. The adoption of the standard size, 6 by 9 inches, and round corners, is commendable.

THE TRUMP BROTHERS MACHINE CO., of Wilmington, Del.. have let contracts for a large extension to their shop, and are adding a number of new tools—lathes, milling machines and drill presses—to their plant. They have been running their full force until 9 P. M. for some time, and have more work than they can turn out.

ONE OF MANY.

Worcester Mass. Nov. 16th 1894

Industrial Press
411 Pearl St New York.

Gentlemen

A bundle of "Machinery's" were received a few days since and were distributed among the men in the Repair shops of the Washburn and Morse Mfg Co. with the result that we have a list of names nearly ready to send for one hundred new subscribers Every body who saw it wanted it and the price was so low that no one hesitated to put down their names

We wish our subscriptions to commence with the first issue. Will you kindly advise me if you will mail each copy to a separate address. Also specify how all shall be made payable for all together

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Foreman of Repair Shops Washburn & Morse Mfg Co.

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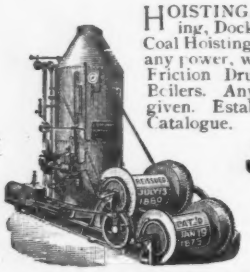

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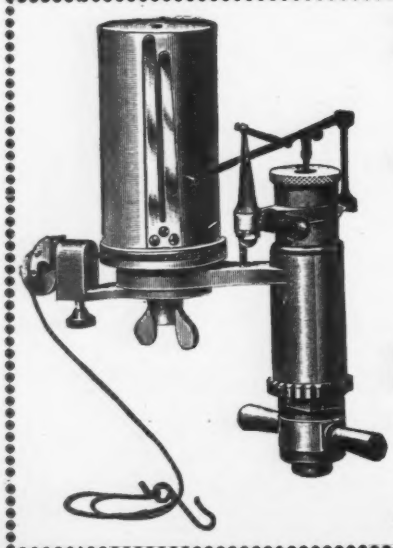

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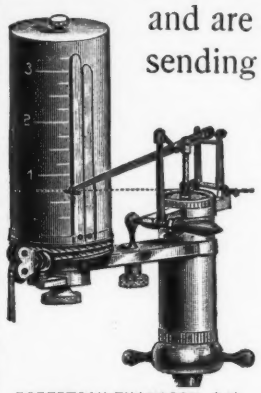

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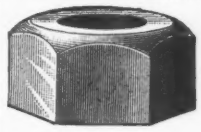

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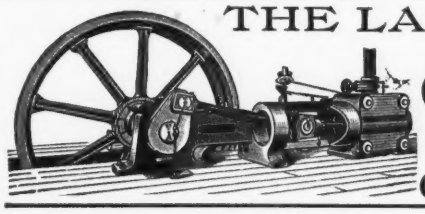

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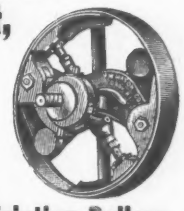

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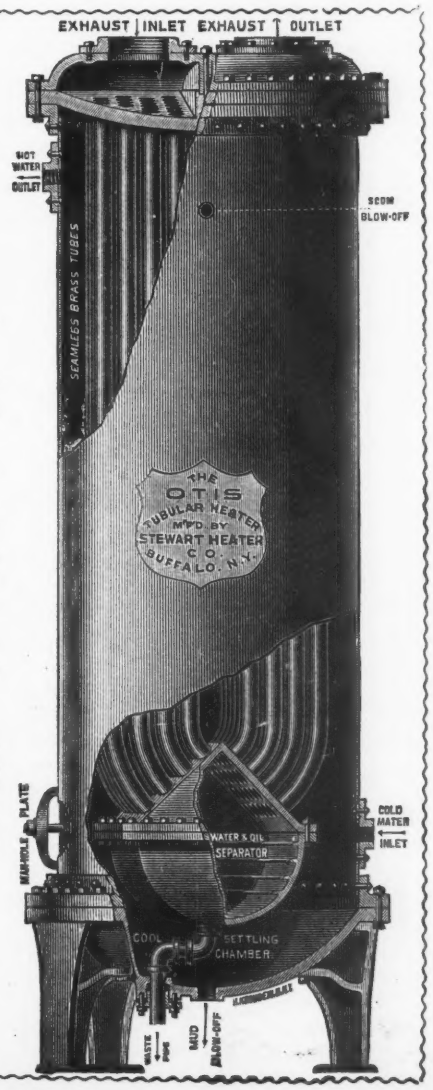

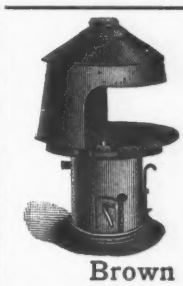

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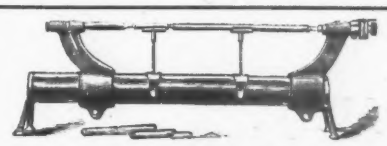

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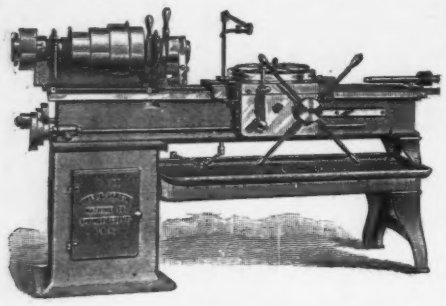

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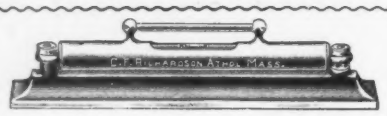

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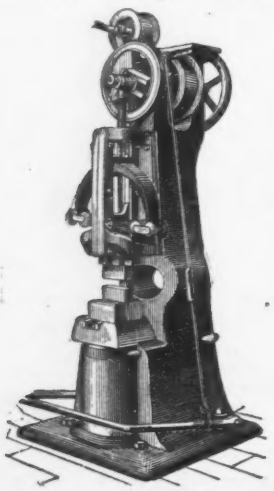

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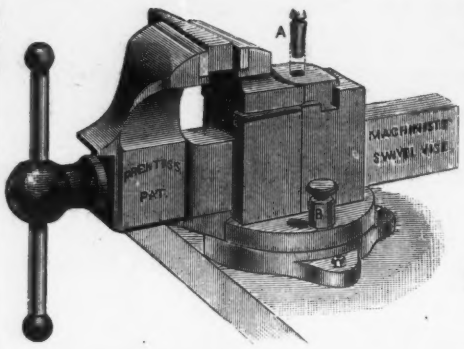

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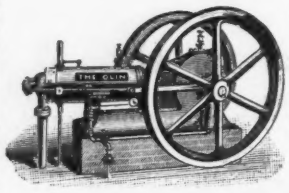

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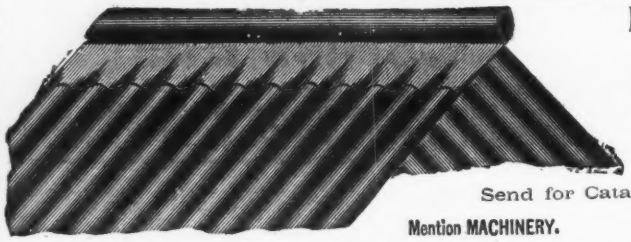

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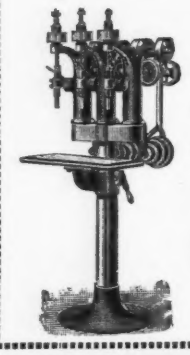

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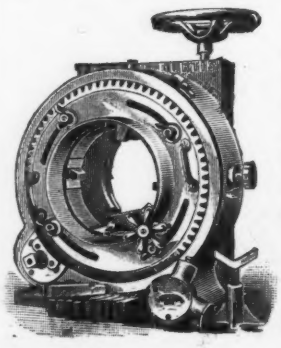

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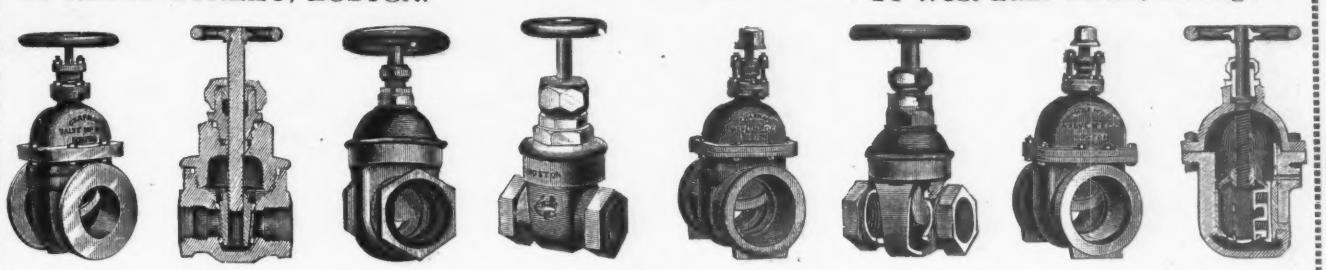

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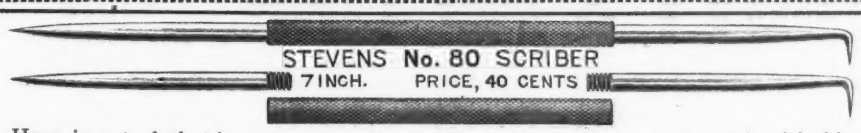

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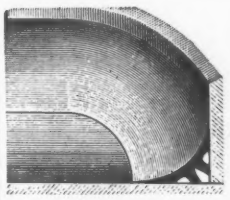

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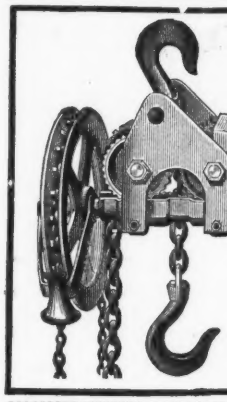

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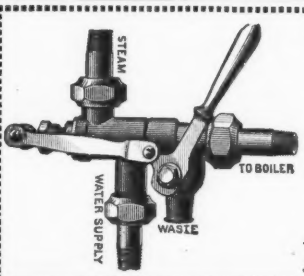

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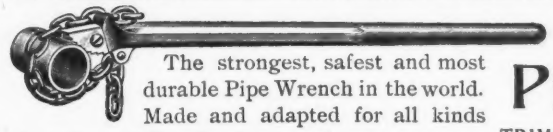

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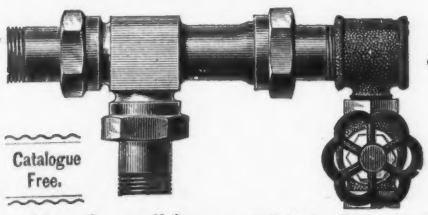

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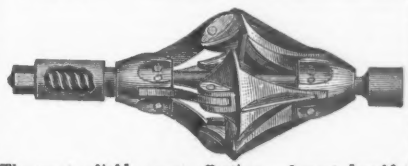

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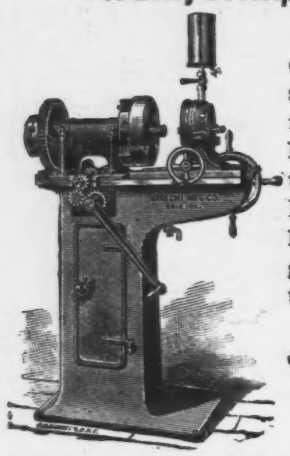

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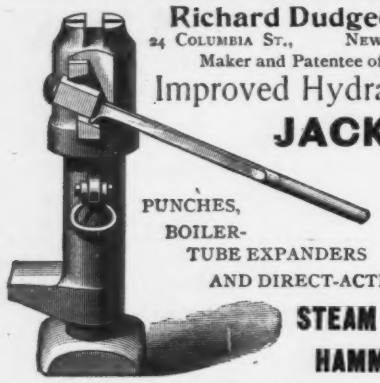

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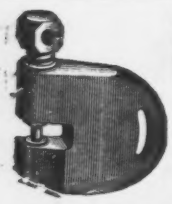

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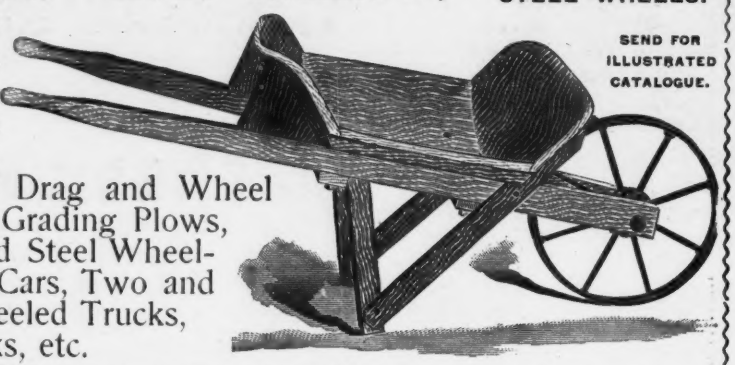

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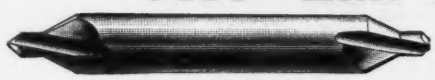

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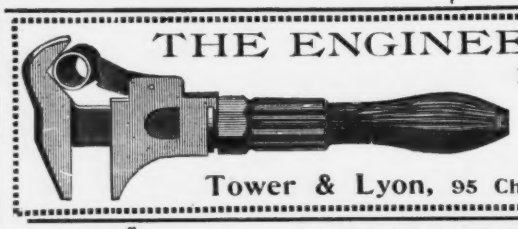

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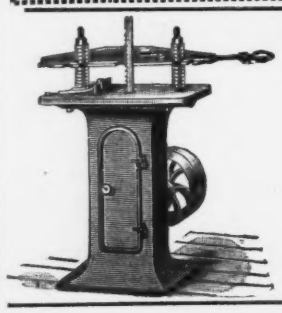

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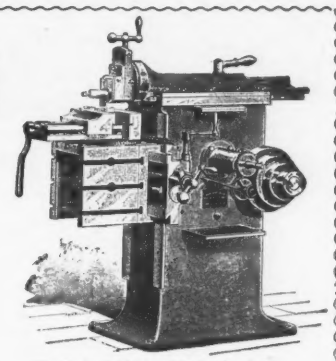

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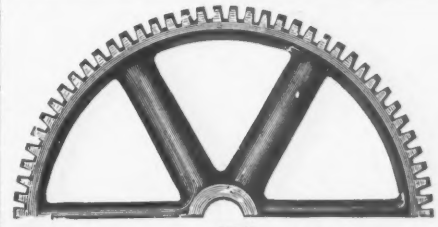

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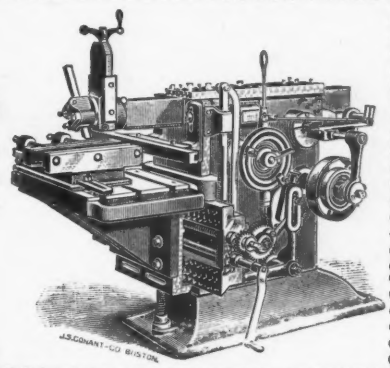

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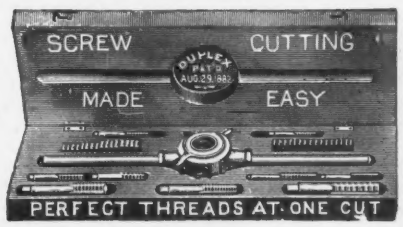

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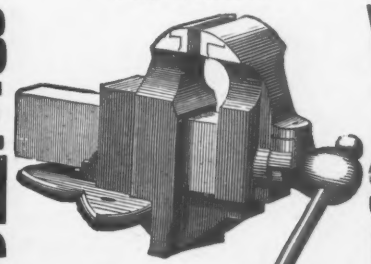

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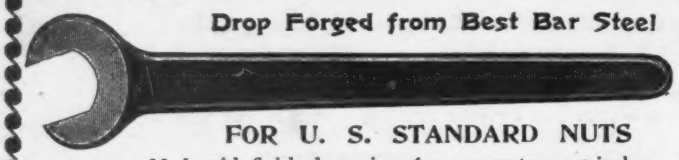

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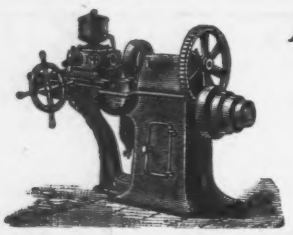

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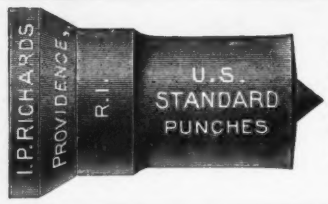

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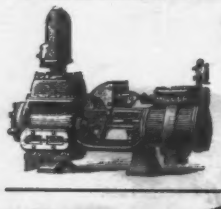

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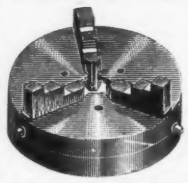

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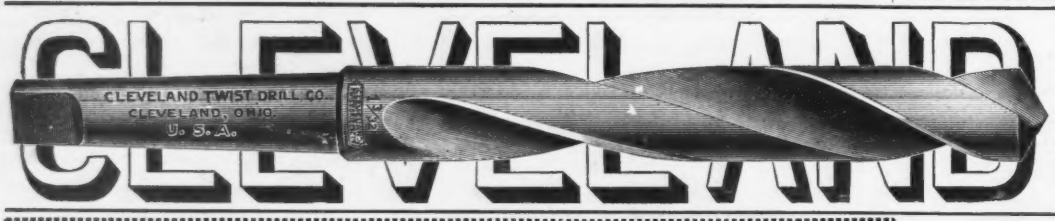

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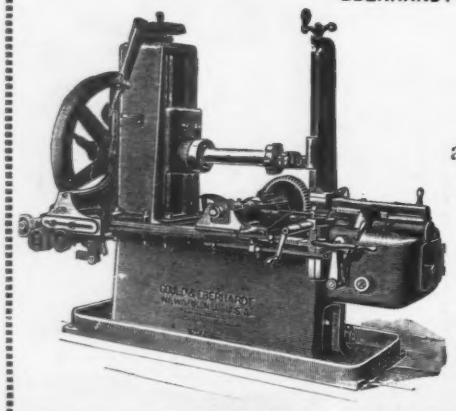
EBERHARDT'S PATENT



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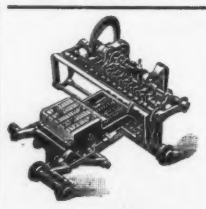

It is a Calculating Machine and it will save error, labor, and time on common addition, multiplication, etc. You can get an interesting descriptive circular from Geo. A. Grant, Lexington, Mass.